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THE EAR.

THE ANATOMY OF THE EAR, INCLUDING EMBRYOLOGY AND HISTOLOGY.

BY BURTON ALEXANDER RANDALL, M. A., M. D., Ph. D.,

OF PHILADELPHIA.

Embryology.—The human organ of hearing first appears in early embryonic life on each side of the head posteriorly as a pit-like involution of the epiblast (Fig. 434), which closes in to form a spherical "otic vesicle" (Fig. 435). Bud-like hollow processes grow out from this—inward, to form the endolymphatic duct and sac; forward, as the spirally-coiled cochleal tube (Fig. 436); outward, upward, and backward, in curving course to meet and coalesce with similar outgrowths and form the three semicircular canals, each with a flask-like dilatation where one of its ends springs from the vesicle. This has meanwhile lost its spherical form, dividing into a more spherical anterior "saccule," connected with the cochleal tube by a narrowed "*canalis reuniens*" and an ovoid "utricle" communicating with the semicircular canals by five openings—one non-sacculated termination being common to the vertical and the posterior canal. The tissue which effects this cleavage extends up into the endolymphatic duct (Fig. 437), so that the two sacs, although in contact, communicate only by this now Y-shaped tube.

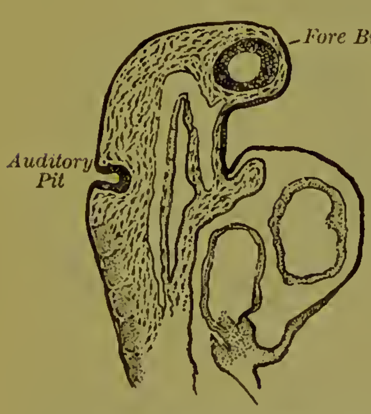


FIG. 434.—Sagittal section of embryo, showing involution of epiblast to form the otic vesicle.

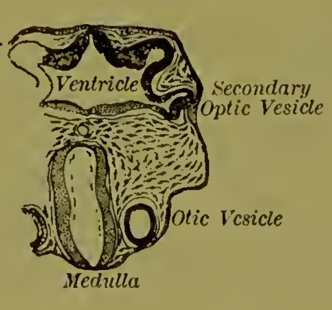


FIG. 435.—Horizontal section of head through the developing eye and full-formed otic vesicle; third week in human.

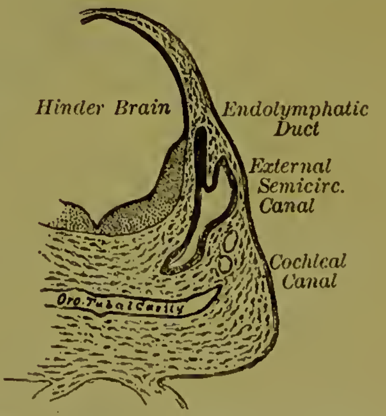


FIG. 436.—Horizontal section through developing labyrinth, medulla, and mouth; fifth week.

Within the otic sac, which has now come to deserve the name of membranous labyrinth, there has been marked differentiation of the cells; while externally a fibrous envelope has been formed from the mesoblast, splitting into a perichondrium sheathing the cartilaginous tissues which have been encasing the structure, separated by spaces of growing complexity from the delicate basement-membrane which supports all parts of the labyrinth. Supported by this, the simple rounded neural cells, generally in single layer, flatten into pavement-cells throughout most of the extent of the semicircular canals, the utricle, the saccule, and part of the cochlear tube; but at each point where the developing acoustic nerve sends fibers the cells assume a columnar form, surmounted by short, stiff cilia, the "hair-cells," above which floats a layer of gelatinous material of doubtful function, but invariable and early presence. Each of the flask-shaped ampullæ of the semicircular canals presents such an area, the "acoustic crest," upon its concave side; larger areas are present in the saccule and in the utricle, as shown in Fig. 437, the gelatinous "blanket" of each of the latter loaded with small crystals of lime —the *otoliths.* In the cochlear tube the corresponding structure, called after its discoverer "Corti's organ," is extremely complex and merits more extended description.

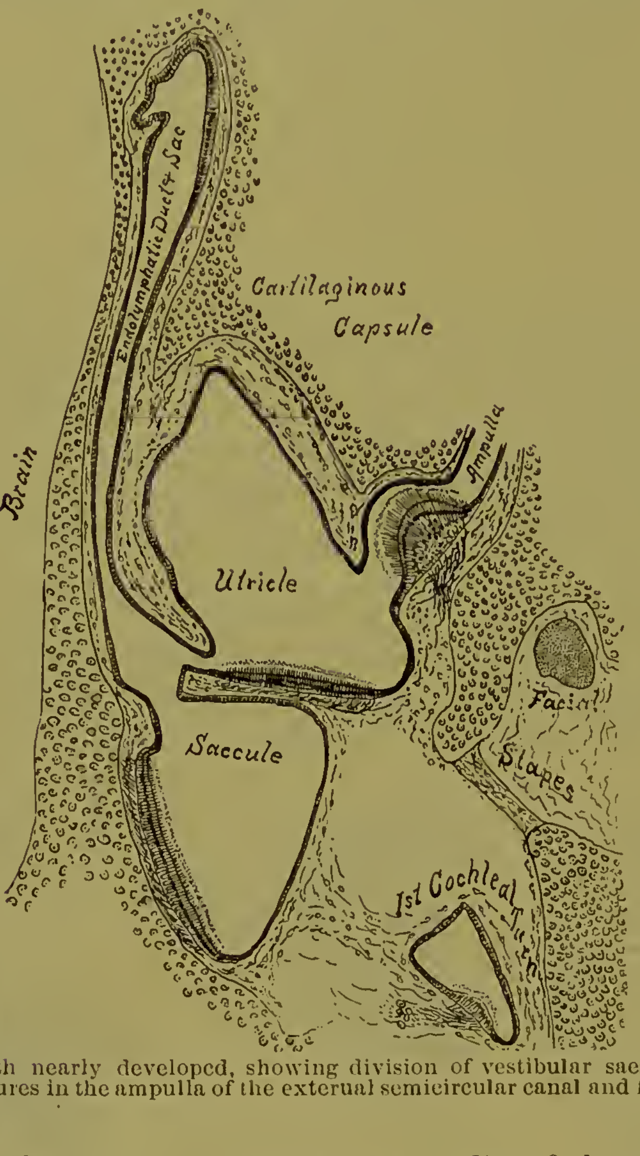


FIG. 437.—Labyrinth nearly developed, showing division of vestibular sacs, their hair-cell areas, and the similar structures in the ampulla of the external semicircular canal and first turn of the cochlear tube (half-schematic).

Within the open spiral of the cochlear tube there forms a cartilaginous, early-ossifying conical axis, "the modiolus," permeated with openings for the fibers of the cochlear branch of the nerve, which fills the end of the internal auditory meatus at the base of the cochlea and sends its separated fibers through a spiral series of openings into the windings of the structure (Fig. 438). From this conical axis a delicate ossifying shelf is pushed out, ensheathing the diverging nerve-fibers to their entrance into the cochleal tube, and by a fibrous extension underlying the inferior (mesial) surface of this tube. These structures, winding spirally like the other portions of the cochlea, vary greatly in their relative size from the base to the apex: for the "basilar membrane," with its stiff radiate fibers, is narrowest below, where all the other structures are at their largest, and broadens progressively upward at the expense of the bony "*spiral lamina*." As its tense radiate fibers are probably comparable to the strings of a harp or piano, responding to notes higher and higher in proportion to their shortness, this is a fundamental fact in the anatomy and physiology of the organ, as proven by a growing amount of pathological investigation (see pp. 644 and 773).

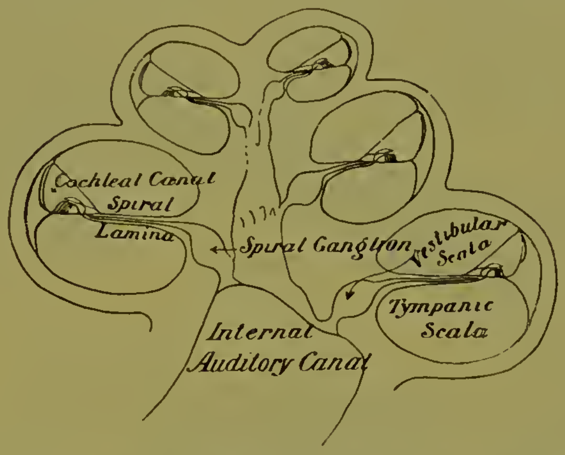


FIG. 438.—Section of the human cochlea showing the two and a half windings of its scalæ.

The cochleal tube, originally cylindrical, has now been compressed to a triangular section, one side of it, as stated, being flattened by the basilar membrane. Below and above this, the cavities formed between the layers of surrounding mesoblast constitute parallel channels winding spirally upward and known as "tympanic and vestibular scala;" beyond these the ossifying cartilage forms a firm protecting spiral, which gives the ultimate snail-shell form from which the cochlea is named. Similar spaces about the saccule, utricle, and semicircular canals hold away the bony walls which ultimately surround them, except at some one point, generally the convexity, as in the cochlea and the semicircular canals. At the attached point, where the vascular supply is best, the neural epithelium is modified to form secreting cells of the endolymph, those in the cochleal tube being a gland-area of cylindrical cells on the outer wall—the "*stria vascularis*" (Fig. 439). The upper wall of the tube becomes exceedingly delicate ("Reissner's membrane"), the neural cells flattening to a delicate pavement, separated by thin fibrous tissue from the endothelial pavement without. The lower wall shows the greatest modification both of the cells and of the supporting mesoblastic tissues. A fibrous crest forms by thickening of the periosteum of the osseous lamina, ending outward in projecting teeth, to which is attached the gelatinous membrane (m. tectoria of Corti) before mentioned as present above all hair-cells. Of these four or five rows are present, supported inward and outward by spheroidal cells, large, vacuolated, and piled upward. Within, two more modified rows of pillar-cells (Corti's rods) form a tunnel beneath their arch.

Each set has broadened feet and heads, the outer set nearly twice as numerous as the inner, and connected outward with a network of phalanx-shaped elements—"reticular membrane"—through the meshes of which the outer hair-cells protrude. These latter are double cells—the lower fusiform and firmly attached below to the basilar membrane by a slightly broadened foot, while the upper process adheres to the side of the peg-shaped hair-cell, and probably is attached to the reticular membrane. The acoustic nerve-fibers pass out between the plates of the osseous spiral lamina after emerging from the "spiral ganglion," which occupies a canal in the modiolus at the root of the lamina. Losing their sheaths, the axis-fibers are sent through a row of openings below the Corti teeth to split into ultimate fibrils, which pass, some up to the inner hair-cells, some across the tunnel to the outer hair-cells, while some wind upward along the spiral tunnel.

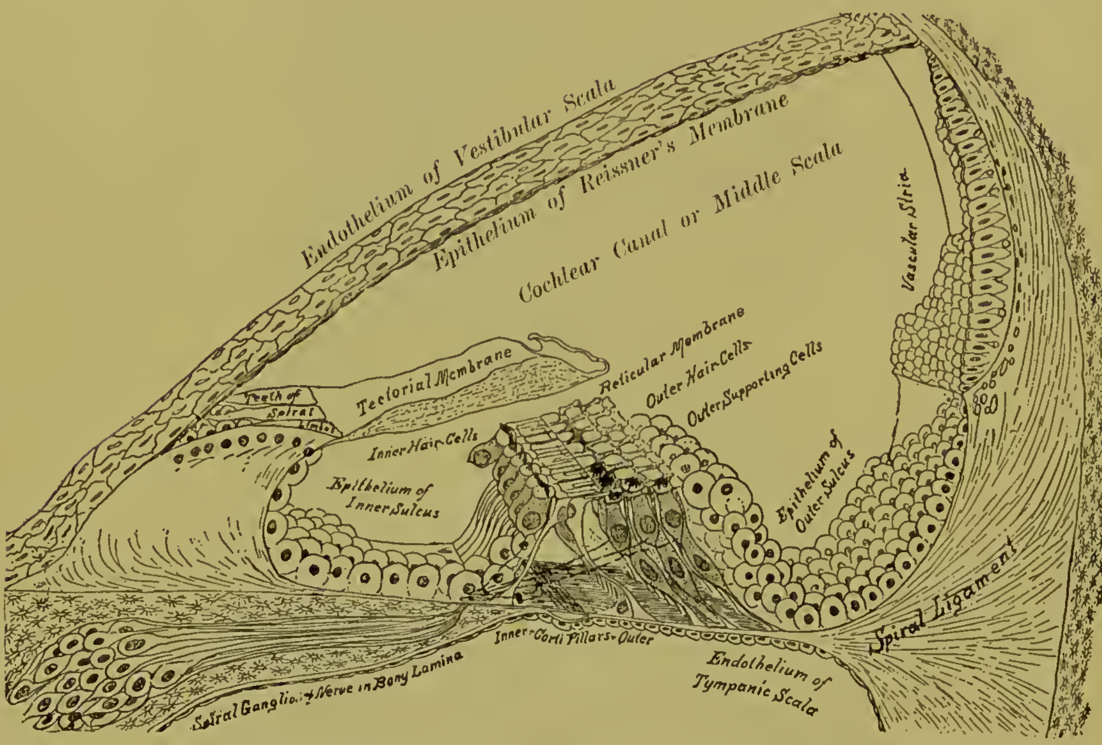

Endothelium of Vestibular Scala
Epithelium of Reissner's Membrane
Cochlear Canal or Middle Scala
Vascular Stria
Tectorial Membrane
Reticular Membrane
Outer Hair-Cells
Outer Supporting Cells
Teeth of Spiral Limbus
Inner Hair-Cells
Epithelium of Inner Sulcus
Epithelium of Outer Sulcus
Spiral Ligament
Inner-Corti Pillars-Outer
Endothelium of Tympanic Scala
Spiral Ganglion & Nerve in Bony Lamina

FIG. 439.—Scheme of section of cochlea in perspective, from human specimens.

Osteology.—Embryological study has made clear the greater importance, formatively as well as functionally, of the membranous labyrinth. Yet the bony labyrinth was much earlier known and described, and was deemed the structure giving shape to its softer contents (Fig. 440). Its beauty, when carved out of its setting in the dense petrous bone, as is easy in infancy, or of its cast in metal when liberated by corroding away the bone, has attracted to it study which it does not otherwise deserve. It communicates with the middle ear by two fenestræ. The lower "round window," closed by the delicate in-drawn *membrana tympani secondaria*, connects with the lower cochlear scala, hence called tympanic; while the upper "oval window," normally occupied by the foot-plate of the stapes, communicates with the vestibule, which contains the utricle and saccule, separated from the oval window by a space of nearly 2 mm.—the "cisterna perilymphatica." This space is directly continuous with the upper "vestibular scala" of the cochlea. Depressed cribriform areas on the mesial wall of the vestibule admit the nerve-fibers to the sacs of the membranous vestibule, the saccule occupying the hemispherical and the utricle the hemielliptical fossa (Fig. 441).

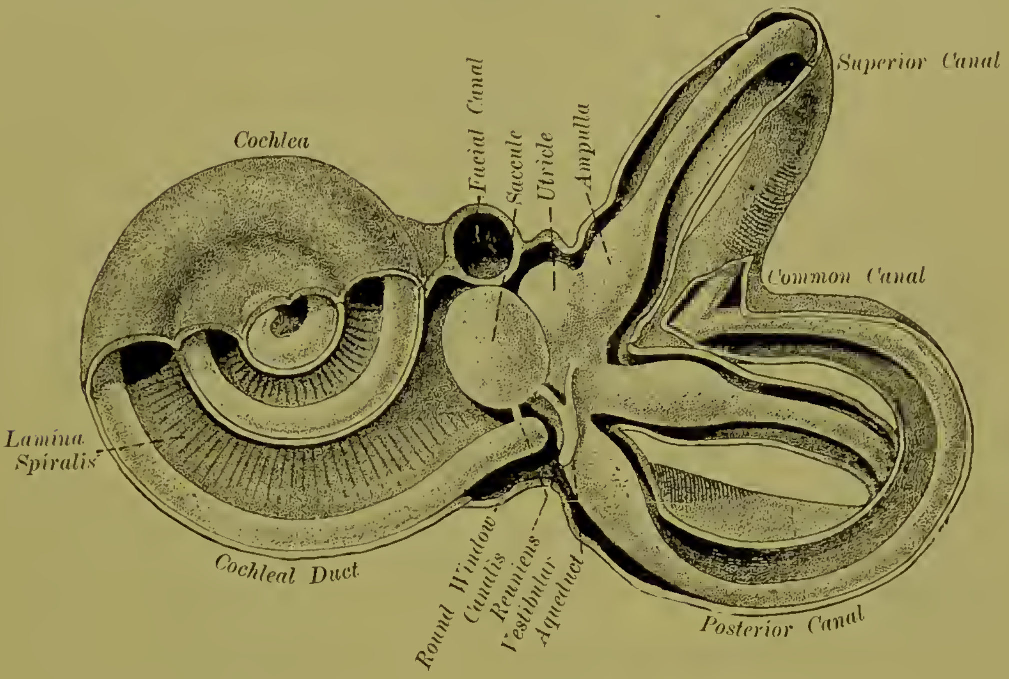


FIG. 440.—Bony and membranous labyrinth (schematic).

Inward the ossifying cartilage grows around the acoustic and facial nerves, forming the internal auditory meatus, shallow in infancy, but becoming a deep narrow canal later.

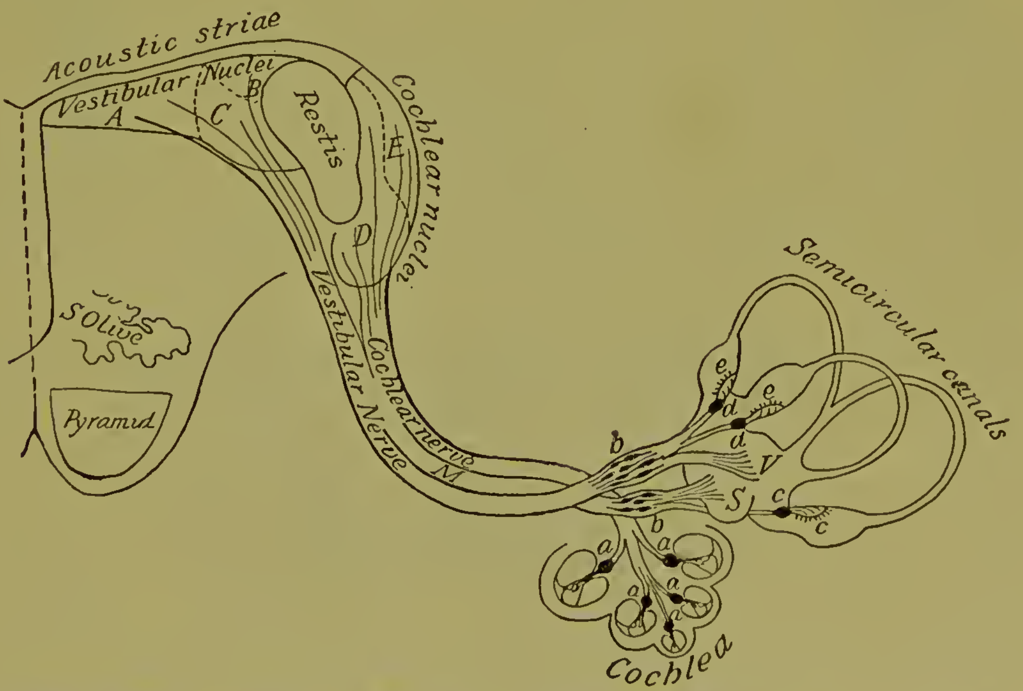


FIG. 441.—Diagram of the origin of the acoustic nerve and its distribution to the organ of hearing (Mills).

The first inner branchial furrow of the embryo early narrows at its outer portion leaving little lateral extension to represent the future Eustachian tube, which does not begin its development until the labyrinth is almost full formed; then it extends outward as a narrow cleft, gradually separating the labyrinth from the tissues without, in which the ossicles are developing, largely from Meckel's cartilage (Fig. 442). Near the closed outer extremity of the cleft, seven little cartilaginous nodules grow to form the auricle; while in their midst an invagination of the surface forms the external auditory meatus, which presses inward until only the handle of the malleus and the thin *membrana propria* of the drumhead intervene between the cutaneous lining of the meatus and the mucous membrane of the tympanum. The old theory is baseless that the drumhead grows as a septum across the canal, and might fail to do so, leaving a colobomatous opening. When a fistulous opening persists, it is almost always from imperfect closure of the branchial cleft, and shows above the tragus, at the root of the helix, as a tiny fistula (see Fig. 483).

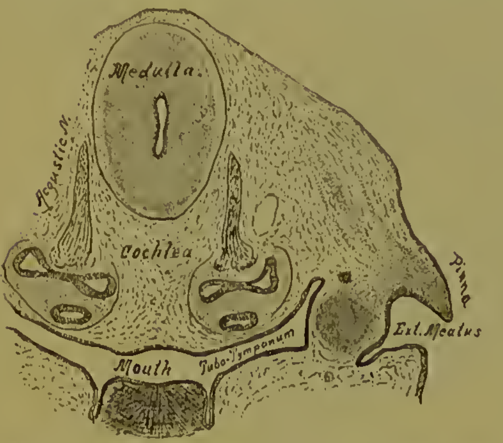
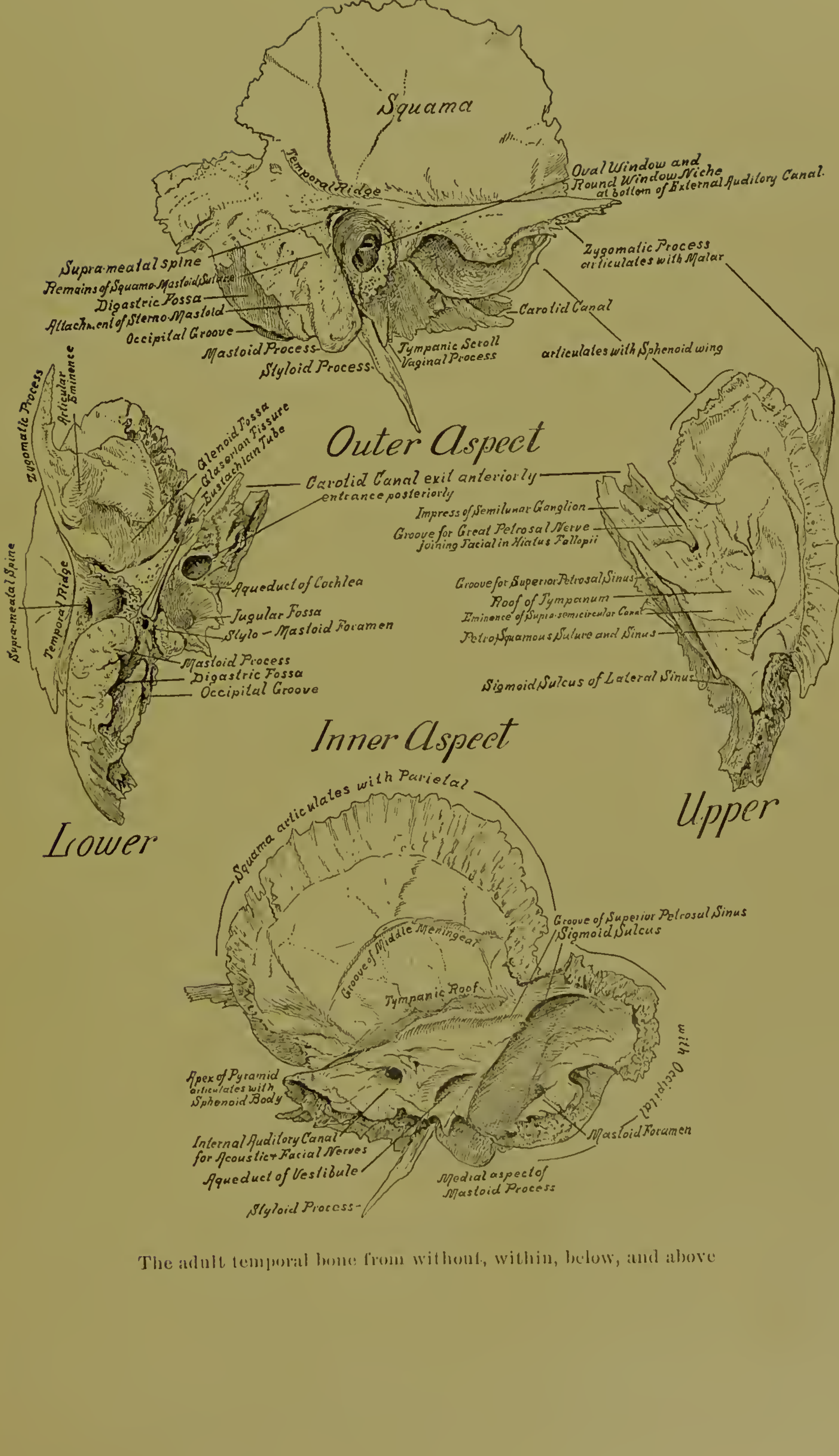


FIG. 442.—Horizontal section through cochlea, tympanum, and external ear of rat (half-schematic).

Besides the ossifying centers of the labyrinth three principal adjacent foci form—one in the petro-mastoid cartilage to imbed the inner ear and inwardly bound the tympanic portion. A second, called the "annulus" in the infantile form, is a ring incomplete above (Fig. 443), but develops into an extensive scroll later, forming all but the upper posterior wall of the auditory meatus. A third center in the membranes above the ear forms the squama, the zygomatic process, the outer half of the tympanic roof, and the *scutum*—the plate which roofs in the external meatus and forms the outer wall of the attic and antrum portions of the tympanum. Another (post-natal) center forms the styloid process. The temporal bone at birth is readily separated into annulus, squamous, and petro-mastoid portions, the last of which is still spongy, and can be cracked away from the enclosed labyrinth as a nut-shell from its kernel. Later the sutures unite almost completely, and the bony labyrinth blends imperceptibly with its strong, hard envelope, and we obtain the temporal bone as usually described in the anatomical treatises, with which the reader is supposed to be familiar. The further notes on the adult temporal bone will therefore be topographical and surgical.

The Adult Temporal Bone (Plate 9).—The outer aspect of the bone looks much more downward than is generally realized, although presenting as many minor variations in this as in all other particulars. One important "orientation point" is the upper edge of the zygoma, which is almost invariably horizontal. Less definite for determining its true position in the vertical plane is the auditory canal, the axis of which (so far as the line can be determined for so curved and tortuous a tube) points on an average 10° below and 10° back of the horizontal transverse axis of the head. Its deviation in each direction varies from 0° to 20° in individual cases. Sharing the general proportions of the cranium, the temporal bone varies hugely in size, massiveness, and configuration, its structure rarefying with advanced life to a delicacy like that of childhood, while its mastoid process corresponds to the muscular development to which its growth is a response. The pneumatic cells within hardly appear before adolescence, and probably enlarge and coalesce progressively throughout life; and nature's economy of material

PLATE 9.


Squama
Temporal Ridge
Oval Window and Round Window Niche at bottom of External Auditory Canal.
Supra-meatal spine
Remains of Squamo-Mastoid Suture
Digastric Fossa
Attachment of Sterno-Mastoid
Occipital Groove
Mastoid Process
Styloid Process
Tympanic Scroll
Vaginal Process
Carotid Canal
Zygomatic Process articulates with Malar
articulates with Sphenoid wing
Outer Aspect
Zygomatic Process
Articular Eminence
Glenoid Fossa
Glaserian Fissure
Eustachian Tube
Carotid Canal exit anteriorly
entrance posteriorly
Supra-meatal Spine
Temporal Ridge
Aqueduct of Cochlea
Jugular Fossa
Stylo-Mastoid Foramen
Mastoid Process
Digastric Fossa
Occipital Groove
Impress of Semilunar Ganglion
Groove for Great Petrosal Nerve joining Facial in Hiatus Fallopii
Groove for Superior Petrosal Sinus
Roof of Tympanum
Eminence of Supra-semicircular Canal
Petro-Squamous Suture and Sinus
Sigmoid Sulcus of Lateral Sinus
Inner Aspect
Lower
Upper
Squama articulates with Parietal
Groove of Middle Meningeal
Tympanic Roof
Groove of Superior Petrosal Sinus
Sigmoid Sulcus
with Occipital
Apex of Pyramid articulates with Sphenoid Body
Internal Auditory Canal for Acoustic + Facial Nerves
Aqueduct of Vestibule
Styloid Process
Mastoid Foramen
Medial aspect of Mastoid Process

The adult temporal bone from without, within, below, and above

gives to the large process the more pneumatic structure. Diploë is present, as in all the cranial bones, but is in inverse proportion to the air-spaces. The type of the cranium and the external configuration of the temporal afford no criterion as to the topography of the bone, except that we may generally expect to find a large mastoid, thin-walled and large-celled. The mastoid may be said to extend up to the curving temporal ridge which extends backward and upward from the root of the zygoma, and has been used as an index of the level of the middle cerebral fossa within, as in Macewen's chosen "post-meatal triangle;" but this cannot be relied upon as a landmark. Up and back from the canal a small spine with a depression back of it can be almost invariably recognized as marking the back margin of the meatus. This is a most important surgical landmark, as the point of election for opening the mastoid is close behind it. The floor of the middle fossa at the nearest point averages 6 mm. above it and is probably never lower than this spine: I have found it as low but 5 times in 1000.

This fossa, which constitutes most of the superior aspect of the bone, is of uneven surface, marked with the gyri of the cerebrum, and shows the petro-squamous suture in childhood and sometimes into adult life. It is covered with thin, strong *dura mater*, which sends fibrous prolongations into the suture, and is most firmly attached along the back edge of the pyramid, where it passes into the tentorium and is split to form the superior petrosal sinus (see Plate 10, Fig. 1). Another sinus follows the petro-squamous suture, after which it is named, and emerges at the root of the zygoma, large in fetal life, but generally tiny after birth, and shrinking to a fibrous thread, although occasionally persisting of good size through life, and burrowing more or less under bridges of the inner surface of the bone. A groove more mesial in the floor accommodates the great petrosal nerve as it passes from the spheno-palatine ganglion backward to the facial canal to blend with the facial nerve at the geniculate ganglion—structures which are often devoid of bony covering (at the *hiatus Fallopii*) in infancy, and at times in adult life. Below the tentorium is the posterior or cerebellar fossa, bounded forward by the posterior aspect of the petrous pyramid. Here the internal auditory meatus, of very varying width and depth, is in close relation with the apparent origin of the facial and acoustic nerve in the pons; and, hidden close by in the layers of the dura, the endolymphatic sac communicates through a long cleft—the vestibular aqueduct—with the interior of the membranous labyrinth. Far-

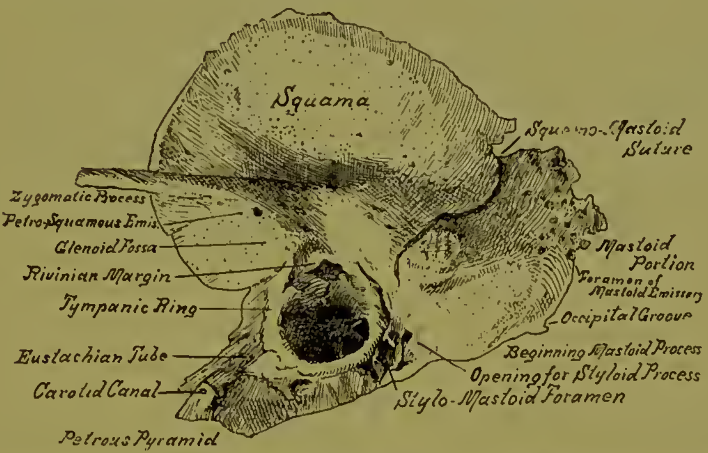


FIG. 443.—Temporal bone of infant; lower-outer surface showing squamous, tympanic, and petro-mastoid segments.

ther outward and backward the lateral sinus, leaving its course in the edge of the tentorium, sweeps downward and in to find exit into the bulb of the jugular, forming the sigmoid sulcus upon the base of the pyramid, and a still more marked turn as it passes through the foramen lacerum (Plate 10, Fig. 2). No point in human anatomy is subject to greater variation as to size and position than this sinus and the jugular bulb continuous with it. Formed at the *torcular* by the confluence of the longitudinal sinuses, the lateral sinus, generally quite unequal in size on the two sides, passes out and forward (transverse sinus) to receive the superior petrosal as it curves down at the posterior end of the crest of the pyramid, to give off the mastoid emissary as it turns inward, and to receive the inferior petrosal as it passes forward at the *foramen lacerum.* As most of the blood-current of the superior longitudinal sinus usually flows to the right, this is oftener the larger and grooves more broadly and deeply the temporal bone at the sigmoid sulcus, extending farther forward and outward with its stronger curves. This cannot be counted upon, however, as rendering the left temporal any safer for easily avoiding the sinus in surgically opening the mastoid. The space between the sigmoid sulcus and the antrum is smaller, actually as well as relatively, in adult life, but rarely exceeds 5 mm., while some 10 mm. usually intervene between it and the posterior wall of the external canal. A large curved or bulbous sinus always approaches close to the canal and to the mastoid cortex, and little or no bone may protect it in one or both of these directions. The fossa in which the bulb of the jugular is lodged is also of infinite variation. Its depth occasionally carries it actually into communication with the internal auditory meatus: it generally closely approaches the lower back part of the tympanic cavity (Fig. 446), with the intervening bony septum at times dehiscent, and it so trenches, in rare instances, upon the labyrinth that its walls are marked by the semicircular canals. The mastoid emissary vein curves in variable fashion out and back from the lower curve of the sigmoid and passes by single or multiple channels through the bone, to emerge at or near the occipito-temporal suture. It varies from a tiny vessel hardly more than a nutrient of the bone to a large sinus carrying all the blood of the sigmoid sinus to the external jugular. The inferior petrosal sinus, like the superior, passes back from the cavernous and transverse sinuses, gathering the flow of the efferents of the pyramid and adjacent parts. It follows the line of the petro-occipital suture, and is probably of great importance in some cases as the channel of infections from the diseased tympanum.

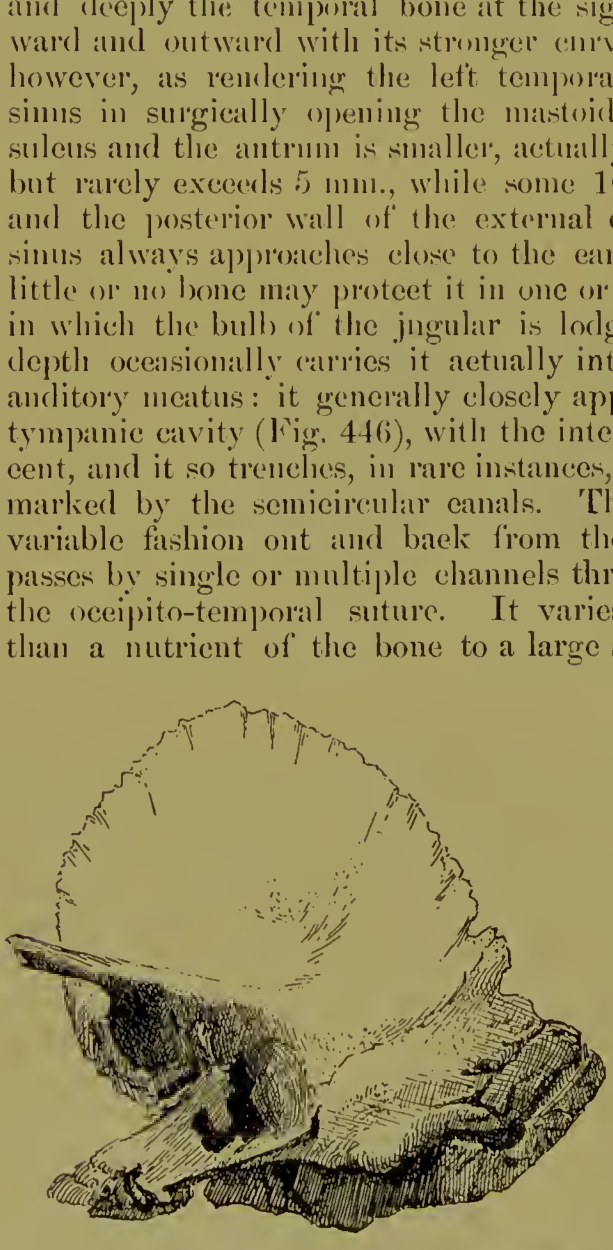


FIG. 444.—Temporal of child, showing growing mastoid process and fenestrated development of the tympanic scroll; sutures almost obliterated.

The lower aspect of the temporal bone is marked by the canals of the carotid artery and the fossa for the head of the jugular, beginning in close proximity, but curving strongly in opposite directions. The first bend of the carotid presses its convexity into close relation to the forward part of the tympanum, and the wall, sometimes dehiscent, is always penetrated by vascular twigs. The outer wall of the canal is

PLATE 10.

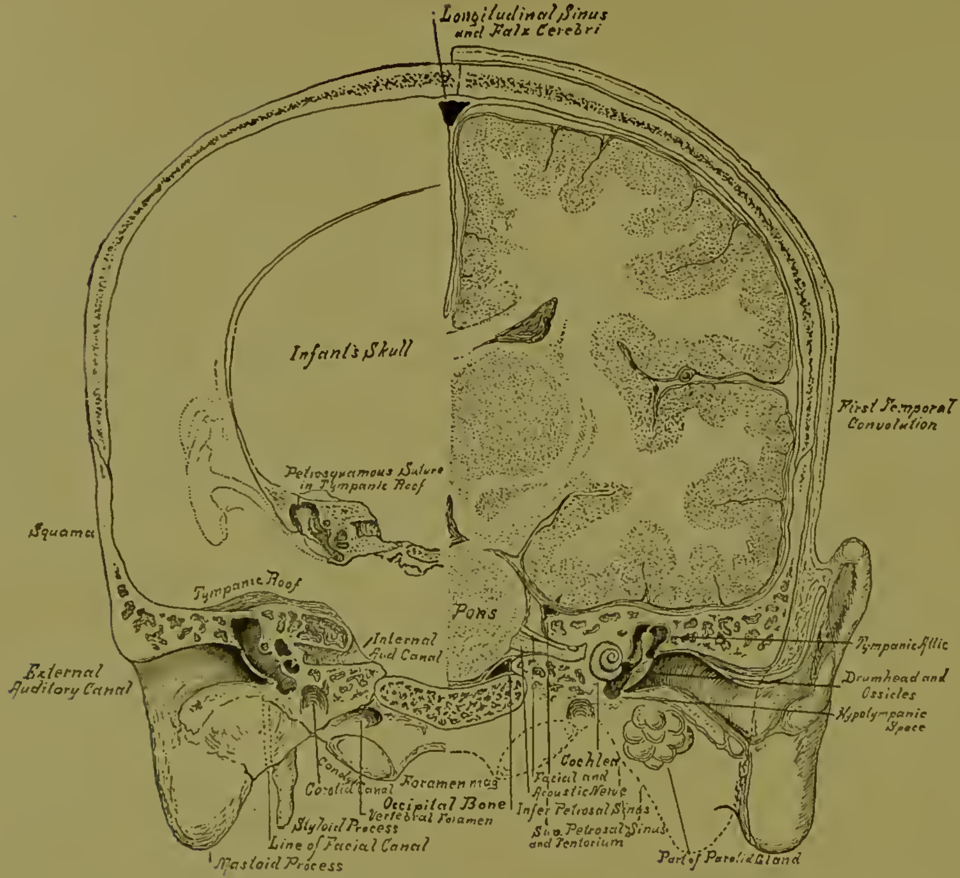


FIG I.—Vertical section through auditory canals, showing the soft parts on the right, the macerated parts on the left.

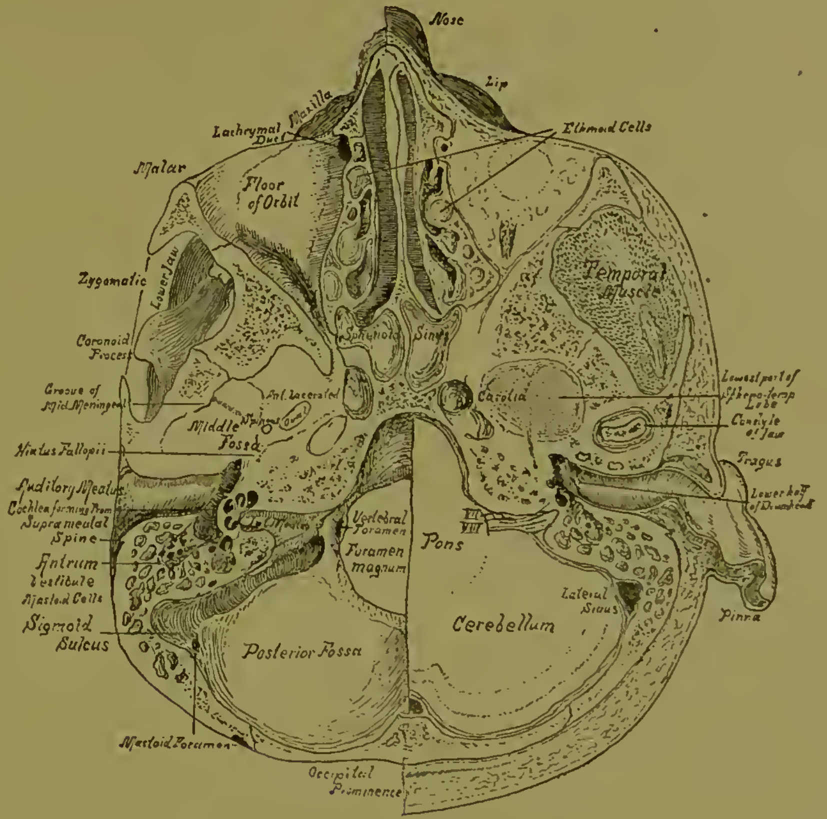


FIG. II.—Horizontal section through orbit, middle ear, and occipital protuberance, with the soft parts on the right, the macerated parts on the left.

in like proximity to the Eustachian tube, and dehiscence is here more frequent—a fact to be borne in mind in bougieing this passage. External to this is the glenoid cavity, its posterior boundary formed by the tympanic scroll—its juvenile foramen often persistent (Fig. 444)—constituting the anterior wall of the auditory canal. The open Glaserian fissure at its inner extremity marks the sutural line and gives place to the gracilis process of the malleus, vessels, and the chorda tympani. The fossa of the digastric grooves deeply the under surface of the mastoid, paralleled mesially by that for the occipital nerve and vessels. While the tip of the mastoid process is wholly external to these, it must not be forgotten that thin-walled pneumatic cells commonly occupy the mesial boundary and may be the source of pus burrowing in the digastric fossa.

The styloid process, partially ensheathed by a lamina of the tympanic scroll, extends down, in, and forward toward the lesser horn of the hyoid. It represents the cartilaginous and fibrous axis of the second branchial arch, undergoing no ossification during the early years of life, but sometimes developing almost to the form of the stylo-hyoid of the dog. It may thus become 10 cm. in length, with articulations, real or suggested, in its length. It may occasionally be recognized clinically in the lateral wall of the pharynx. Between it and the mastoid lies the foramen of exit of the facial nerve. The deep notch between the apex of the pyramid and the lower anterior margin of the squama is occupied by the tip of the great wing of the sphenoid, with its spinous foramen, from which the middle meningeal artery courses over the inner surface of the squama.

The External Ear.—**The auricle, pinna,** or **helix** is formed by the outward growth of the cartilage, carrying the skin-covering in close contact with it. Its form, subject to many minor variations, is fairly constant, and, except at the lobule, closely moulded upon the cartilaginous framework. Its apparent attachment to the head posteriorly is some 20 mm. back of the supra-meatal spine, and fairly corresponds to the region of the mastoid where the lateral sinus is most near the surface (see Plate 10). The rest of the mastoid surface is hairless, and seems to cling closely to the surface which it reveals beneath ; but its marked swelling in diseased conditions proves the presence of much areolar tissue and a chain of lymphatic glands connected with those below and in front of the ear. These are frequently involved in ear-disease, acute or chronic, and may need evacuation or extirpation—steps complicated by the passage of the facial nerve through the superficial group forward and by the adhesions of the deeper set to the sheath of the jugular and carotid. The layers of the cervical fascia concern the aural surgeon greatly in his work, and explain why rupture of mastoid empyema into the digastric fossa lifts the sterno-mastoid and all the neck-tissues, and how it may burrow to the posterior pharynx-wall, down to the clavicle or even into the mediastinum or pericardium. Parotid abscess is also said to endanger the ear by bursting through the fissures of Santorini of the cartilaginous canal—a path about as easily forced were the cartilage devoid of such gaps.

The external muscles of the ear are rudimentary and unimportant, although many have ability to call the attollens into play. The others are occasionally seen in spasmodic action, twitching generally without the consciousness of the person.

The auditory canal, as has been stated, varies greatly in its direction and size, with the result that the structures clinically visible at its bottom are inconstant. The lower anterior segment of the drumhead cannot always be brought to view ; while up and back the incus-shank, stapes, and stapedius-tendon, and down and back the niche of the round window with its prominent anterior lip may often be looked for in vain. The length of the upper back wall usually concerns the surgeon, since it marks the depth of the structures which he may have to attack, while it also gives, as above noted, a clue to the depth of the facial and horizontal semicircular canals which he must avoid (Fig. 445, Pl. 10). This length to the *spina suprameatum* is from 12 to 17 mm., and the soft tissues of the canal lengthen it to about 25 mm. The front wall is longer, since the oblique plane of the annulus places the lower anterior parts of the drumhead some 5 mm. farther in ; while the tragus protrudes a little outward, making it some 35 mm. long. The impression is common—based upon the position of the drumhead as part of the under surface of the prepared head of the infant—that the infantile canal is much shorter than the adult, and the drumhead more superficial. This has hardly any truth, although accepted and taught by many authorities ; for the length of the undeveloped bony meatus is fully represented by its fibrous precursor (Plate 10). Only in so far as the cartilaginous canal is smaller may we look for a few mm. less depth of the drumhead. The caliber is smaller in infancy, and the rather collapsed tube follows the upward curve of the squama, requiring a *downward* and outward traction to straighten it. The adult meatus is very tortuous, as a rule, although occasionally broad and straight. Its lumen is usually oval ; vertically at the exit, but inclining obliquely forward as it passes in, until the axis may be less than 45° from the horizontal. With this there is curvature in the vertical plane and sometimes in the horizontal, so that the inner portion has often a downward trend, although the axis of the outer part pointed 10° to 20° upward. There is commonly some widening of the inner, anterior part, constituting a sulcus close to the drumhead—a difficult place from which to remove wax and foreign bodies, as many have found. The diameter of the canal is very various, as is the type of its oval, the narrowest "isthmus" being generally the most compressed portion, with a minor diameter sometimes as small as 5 mm. In the unmacerated canal the strong curves of the soft parts (Plate 10) still farther complicate the tortuosity, although these can be largely eliminated by good traction, usually up and back and out. Yet the gain is great in getting access surgically to the depths of the canal, if we lay forward the soft parts and work in the shorter, broader tube of the naked bony meatus. In clinical cases, where free access is needed or the widest exit for a foreign body, the jaw must be dropped so as not to press upon the front wall of the canal. That it compresses the outer parts is demonstrable at a glance or by moving the jaw with the finger thrust into the meatus ; but it is generally forgotten that the bony wall often presents in adult life the foramen of lacking ossification near the drumhead, which is a constant feature in the early years of life, and that pressure of the jaw-condyle may be exercised here also.

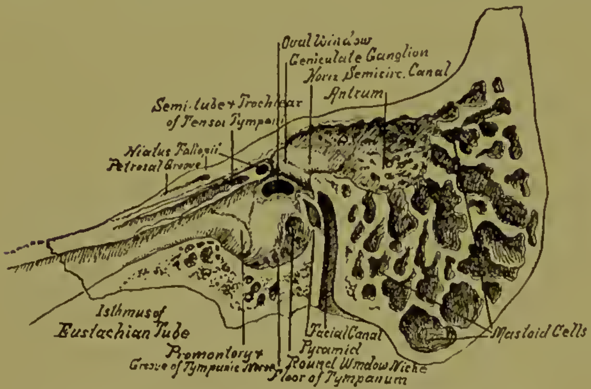


FIG. 445.—Inner wall of tympanum and tube.

The Middle Ear.—The Tubo-tympanic Cavity.—The drum-cavity, like the labyrinth, although varying much in its dimensions in individual cases, is practically of full size at birth, and undergoes little or no change in the development of the temporal bone as a whole. Its full significance anatomically and pathologically is partly lost by those who do not follow Leidy in recognizing its threefold division—in considering the *antrum* as much a part of it as is the *attic* or *atrium*. Much good surgical comprehension and practice has crystallized about the name *attic* for the epitympanic space, and further clarification will be general when the antrum is no longer considered as one of the mastoid cells. The loose vagueness of ideas and terminology which calls the tympanic membrane "the drum" is only less manifest when we ignore this and the relation of the *scutum* (*pars ossea* of the drumhead, Walb) to the upper and posterior tympanic cavities.

Embryology shows us that the Eustachian tube, tympanum, and mastoid cells are one complex and slowly developing structure; and, while the last are possibly merely adventitious adnexa, we may yet learn to better appreciate their unity. Absent, however, at birth, when the organ is otherwise so complete, we may now regard them as unimportant. The tubo-tympanic cavity is a portion of the upper air-passages as much as are the accessory cavities of the nose—lined with an extension of the same nasal mucous membrane with all its pathological attributes. Much of this mucous membrane is at the same time virtually a periosteum, which magnifies its importance physiologically and increases greatly the importance of its lesions.

The tympanum or drum-cavity is in man situated in the midst of the temporal bone, some 20–35 mm. from the opening of the external canal. Its lower portion, the drum-cavity proper, or *atrium*, is bounded outward and down by the annulus and tympanic membrane, and has somewhat the shape of the body of a vertebra—a short cylinder with concave ends: the inward traction of the center of the drumhead and the protrusion of the promontory opposite bring these walls within about 2.5 mm. of each other. This dimension might well be called the height, as it is more vertical than the longer line from floor to roof, which is conventionally so called, the extreme obliquity of the annulus being forgotten. From front to back it measures some 12 mm., of which 9 mm. is bounded by the drumhead. Roof the atrium has none, for the attic is continuous with it above, defined externally by the tympanic

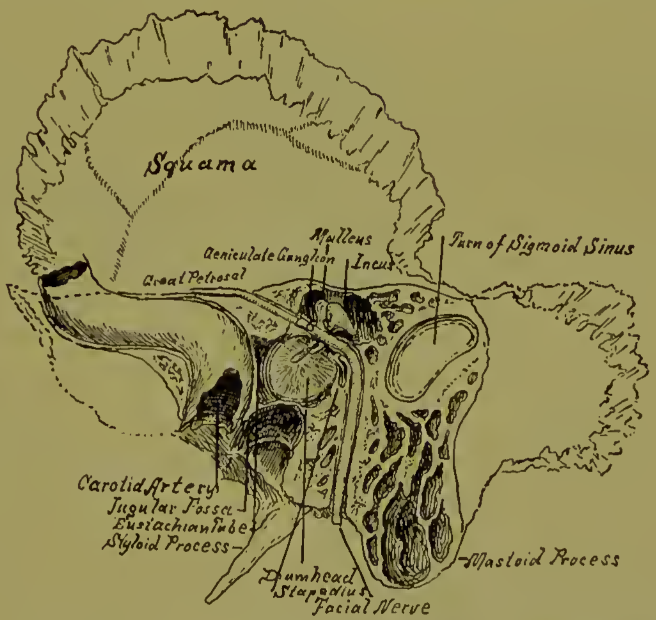


FIG. 446.—Outer wall of drum-cavity and relations of carotid, jugular, lateral sinus, and facial nerve to the tympanum.

margin of the squama, but less definitely elsewhere. Including the 5 mm. of the attic, there is a distance of about 15 mm. from floor to roof, but only two-thirds of this belong to the atrium. The attic space above is broadest at the top, and overhangs markedly the inner end of the canal, with the *scutum*, which separates them, but a thin wedge of bone. It merges almost imperceptibly into the antrum out and back, an hour-glass contraction (*aditus*) being made by the protrusion of the facial and horizontal semicircular canals.

As viewed by the clinician, the drum-cavity seems bounded by the annulus, and through the transparent drumhead or any perforation various inner structures are seen. Anteriorly, the opening of the Eustachian tube makes a deep depression, as its lumen is nearly in line with the axis of the external meatus (they meet at 150° on an average). Down and back the dark niche of the round window (see Fig. 445) is bounded in front by the prominent lip of the promontory (*l*), marking the large beginning of the first turn of the cochlea. Up and back more or less of the shank or descending process of the incus can be seen (*f*, Fig. 447), commonly parallel to the malleus handle, with a horizontal line stretching back from it—the stapedius tendon (*h*). Of the stapes little or nothing can be normally seen in the depths of the *pelvis ovalis*. The curved line of Troeltsch's posterior pocket seems to broaden the handle of the malleus as it spreads upward, until at the incus-shank it meets the whitish line of the *chorda tympani*, which edges the backward sweep of the rest of it. This helps to shadow the stapes, the head and anterior crus of which are hidden by the incus, and come to light only when its shank is displaced or lost. In the floor posteriorly small depressions between trabeculæ of bone give irregularity to what has been called the *recessus hypotympanicus*, important as being often almost or quite trenched upon by the head of the jugular. Above the short process (*a*) and the anterior (*e*) and posterior folds, which can generally be discerned even in the normal drumhead, is the *flaccid membrane*—sometimes defined into anterior (*c*), middle (*d*), and posterior (*g*) portions by visible "suspensory folds"—occupying the gap between the extremities of the annulus, where the tympanic margin of the squama completes the ring. This "Rivinian segment" is usually strongly notched, but varies, and gives varying size to the "Shrapnell's membrane," as it is called after the Englishman who first pointed out its flaccid character. "Rivinian" it is also termed, as the site of the tiny pinhole which Rivinus, following Riolanus, pointed out as a frequent "foramen" here, and which Bochdalek and others have claimed to be congenital. Embryology offers no explanation of its occurrence, and anatomists and clinicians generally unite in denying its usual presence. Unknown in fetal or infantile specimens, it grows more common through childhood, averaging 10 per cent.; and in adult life it may be clinically recognized as a scar or patent opening in 25 per cent. of cases—frequently symmetrically. It is almost certainly the remains of a pathological perforation in spite of any negative history.

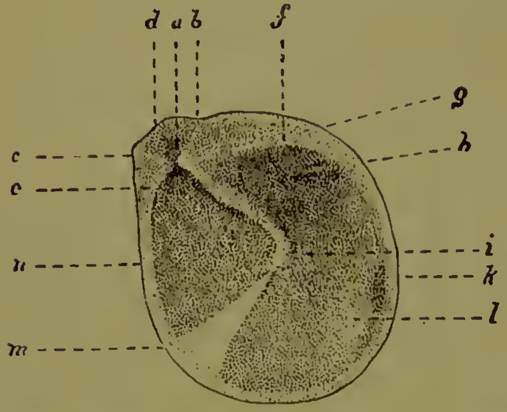


Fig. 447.—Drumhead showing light triangle, malleus handle, and folds about the short process.

This upper region, like many other parts of the tympanum, varies much in its visibility; as the conformation and direction of the canal may render illumination and observation difficult or easy. Especially is this the case in the region of the stapes, which is hidden more or less completely when the canal is horizontal, but shows better the more upward is its inclination. Non-transparency or variability of the drumhead structures has influence in concealing these important parts; but the surgeon who desires access to them should note carefully the axis of the canal in relation to the horizontal plane of the head, as given by the eyebrows, eyes, etc., since it is a criterion for what he may expect as to their apparent location.

The drumhead or *tympanic membrane* is the thinned remains of the tissues which separated the ingrowing external meatus from the outgrowing tubo-tympanic space. Long before birth it has become a delicate *membrana propria* of strong, slightly elastic fibers, the denser, outer layer radiating from the malleus handle, while the inner layer is circular. Both sets merge peripherally into the fibrous tissue of the tendinous annulus which forms the thick margin inserted into the sulcus of the bony tympanic annulus. To the circular fibers, which are most numerous near the annulus and least numerous in the intermediate portion, is largely due the characteristic funnel-shape of the drumhead, which increases when the structure is cut loose from its attachments. They also explain the maintenance of depressed conditions of the drumhead after the cause has been removed. This fibrous basis is clothed externally by the thin skin of the external canal and internally by the mucous membrane of the tympanum. This basis is present only throughout the extent of the *membrana tensa* filling the tympanic annulus. Above, in the Rivinian notch, the flaccid membrane of Shrapnell is almost devoid of fibrous tissue interposed between skin and mucosa. The normal membrane is capable of sustaining a pressure upon either of its surfaces of 15 pounds to the square inch, but will generally rupture under greater stress.

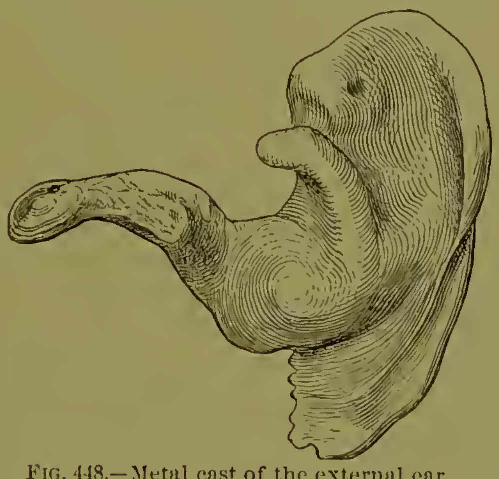


FIG. 448.—Metal cast of the external ear, showing the curves of the canal.

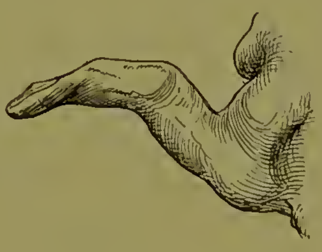


FIG. 449.—Cast of the canal in profile.

The handle of the malleus, partly sheathed in cartilage, is inserted between the layers of the *membrana propria*, although protruding much upon the mesial surface. Folds of the mucous membrane, with more or less of fibrous basis, run backward and forward from the manubrium, in relation in part with the *chorda tympani*, but forming with the drumhead inverted pockets, anterior and posterior. Much variability marks these, like many other tympanic structures, but generally they are well defined and can be seen through the transparent membrane. The annulus is very obliquely set—its plane (not a true plane, as it is slightly spiral) facing downward, outward (37°), and forward (37°). The planes of the two drumheads extended downward and forward would meet at 128°. As the external canal is nearly transverse, averaging 10° upward and 10° forward as it passes inward, but with its innermost portion sometimes curving downward below the horizontal, it meets the drum membrane at a very acute angle. This is best measured upon casts of the canal, which show the upper back wall to pass without demarcation into the drumhead (Figs. 448, 449), while downward and forward the angle may be as small as 30° or less. This depends in part upon the indrawn funnel-shape of the drumhead, which does not lie in the plane of the annulus, but bulges slightly outside of this plane peripherally. It is centrally drawn 1 mm. or more within it by the traction of the *tensor tympani.*

Ossicles.—The two larger ossicles (see Fig. 457) develop from the axis of the first branchial arch (Meckel's cartilage), and are gradually insulated by the development of the tympanic cavity around them. The gracilis process of the malleus, "long" in infancy, but often absorbed or fused to the Glaserian fissure in adult life, is in the seventh week the largest part of the chain. The malleus handle, or manubrium, has been seen to develop in closest relation with the drumhead, which partly ensheathes it; and with the major blood-supply along its posterior border there must be very serious destruction to impair its nutrition. The head is suspended and vascularized from the roof, so that it is less prone to caries than the neck, in contact with which septic collections are apt to be held by Prussak's pouch; so the ossicle may be cut in two. The incus articulates with the saddle-shaped surface by a sort of clutch-joint, engaging snugly when the handle moves inward, but loosely at other times. Neither this nor the incudo-stapedial joint has a definite structure: equally careful students find it a synchondrosis, a true synovial joint with interposed meniscus or an intermediate form. There is a firm capsular ligament with a strong reinforcing band mesially, which constitutes the major support of the incus. When this is destroyed, the delicate attachment to the stapes, if not already severed by the erosion of the incus-shank, the most vulnerable part of the chain, and the stronger semi-articulation of the tip of the horizontal process to the mouth of the antrum, rarely retain the incus in place. The stapes is the virtual key to the value of the chain, and in the absence of the rest can fulfil most of the needs of hearing. Its annular ligament may be considered a synchondrosis with the edge of the oval window, and its foot-plate can be torn away without necessarily tearing the membranous closure of this fenestra. Membranous bands unite the crura with each other and the sides of the niche in most variable manner; but these may be the most important factors in the great majority of impairments of hearing, and their minute and extended study is greatly needed.

The Eustachian tube, some 35 mm. in length in the adult, is a trumpet-shaped canal extending from the pharynx to the tympanum. It is usually collapsed, and presents on transverse section a narrow vertical fissure capable of no great lateral distention. The distal third of its length is supplied with bony walls by the temporal bone; but the longer mesial portion has only cartilaginous support furnished by the "hook cartilage" above (Fig. 450), which in the median half extends down on its posterior wall and constitutes the basis of the prominent posterior lip of the pharyngeal mouth (Fig. 451). The tympanic end also broadens from the narrow isthmus at the junction of the bony and cartilaginous portion, to merge imperceptibly into the anterior part of the tympanum. The tube is lined with columnar ciliated epithelium and its submucosa is full of racemose glands. The basement membrane is in close relation with the cartilage throughout its extent; but where cartilage is lacking, is in like relation to the membranous wall. Two important muscles act upon the tube, the so-called *tensor*, and the *levator veli palati*. The latter lies beneath the tube, and acts upon it only by reason of the upward pressure of its shortening belly, permitting rather than causing the walls to separate. The tensor is more complex in its structure and relation. It arises in part from the hook of the cartilage, which it tends to open by its contraction; other fibers arise from the membranous anterior wall of the tube and tend to draw it away from contact with the opposite wall. Still other fibers arise from the basal cartilage above; but any compressive action upon the hook is probably slight, and I have found a bursa interposed in some cases to facilitate play. Passing downward and forward, the tensor fibers converge to the hamulus of the sphenoid, where the tendon turns inward and spreads in the velum. Weber-Liel has shown that some of the fibers of the tensor are inserted upon the hamulus, and could act, therefore, only as a *dilator of the tube.* Some of the fibers which arise from the hook of the cartilage seem to merge with the fibers of the *tensor tympani* which extend in the opposite direction; and certainly they have common enervation and consonant action. The latter muscle occupies with its belly the canal, partial or complete, which lies along the roof of the bony Eustachian tube, and extends backward and out to the inner wall of the tympanum, where the little tube-like trochlea (Fig. 445) permits its tendon to turn directly outward and, crossing the drum-cavity, to insert itself upon a tiny tubercle on the handle of the malleus nearly directly in from the short process. Disadvantageous as is its leverage, it has abundant power to keep tension on the drumhead through the manubrium. The stapedius, the other intratympanic muscle, is still more snugly lodged in a bony case—the pyramid (see Fig. 445) at the back part of the drum-cavity, between the facial canal and the round window niche. Below, this is open to receive nerve-supply from the facial—above, its cavity curves forward to give exit to its thread of a tendon close to the head of the stapes, to which it is attached. Its action is supposed to be rather antagonistic to the tensor tympani and to limit the pressing of the stapes into the oval window.

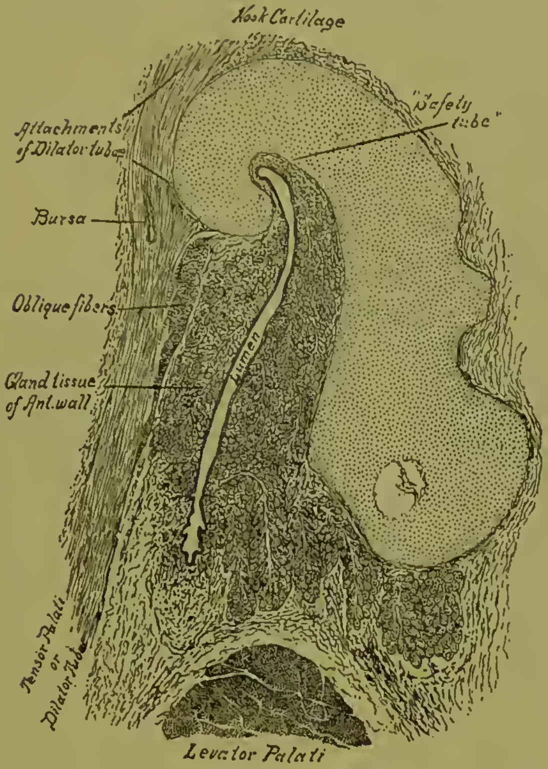

Hook Cartilage
"Safety tube"
Attachments of Dilator tubæ
Bursa
Oblique fibers
Lumen
Gland tissue of Ant. wall
Tensor Palati or Dilator Tubæ
Levator Palati

FIG. 450.—Vertical section of Eustachian tube in the middle third, showing the tubo-palatal muscles.

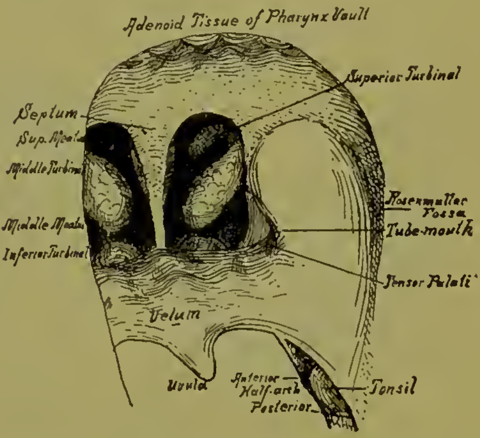


FIG. 451.—Pharyngeal tube-mouth as seen by posterior rhinoscopy.

Plications of the mucous membrane serve with their fibrous basis to suspend the malleus and incus from the roof of the tympanum, to form an external ligament fastening each to the upper tympanic margin and to accompany each of the tensor tendons and the gracilis process respectively. Themselves variable, these bands are reinforced by others less constant, which serve to subdivide the attic space more or less completely into several or, at times, many cavities. One fairly constant "pouch" lies between the neck of the malleus and the flaccid membrane, having the short process for its floor, as described by Prussak. Politzer has found this often subdivided, while Kretschmann thinks the usual condition is for the pouch to extend backward along the body of the incus. Much in the pathology of inflammation in the attic depends upon the individual variations of these parts and the retention of secretions within the spaces thus isolated (Fig. 452).

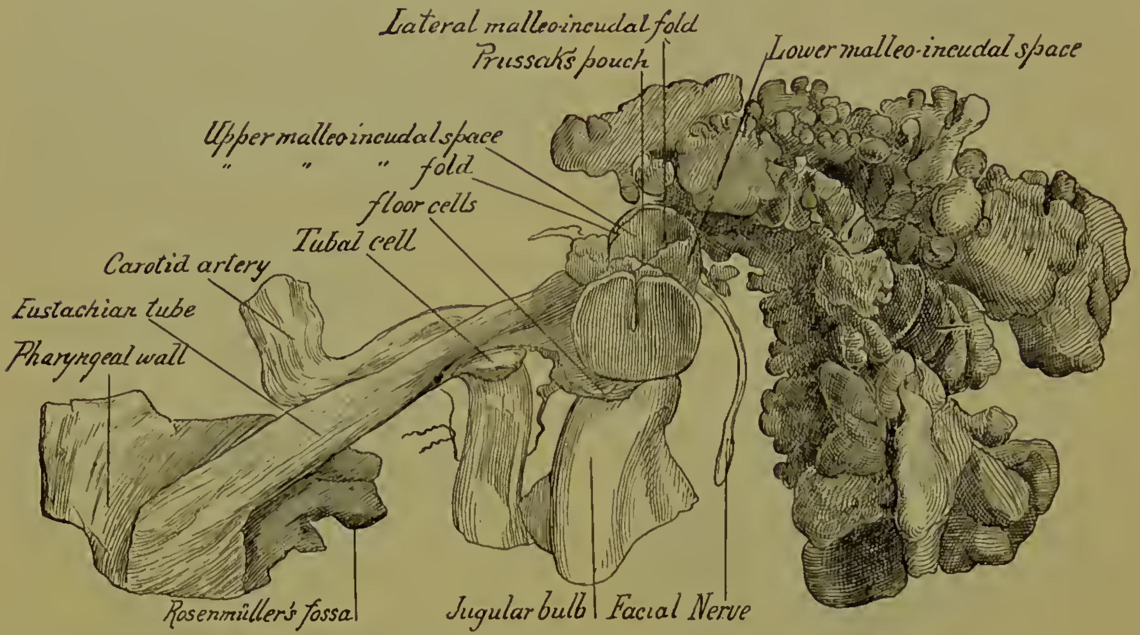


FIG. 452.—Metal cast of the middle-ear spaces, lateral side (Siebenmann).

In the antrum comparable septal bands are often present; and its lining mucous membrane, which extends into the communicating pneumatic cells of the mastoid, often narrows greatly the entrances of these. Although sufficient for good drainage in health, these openings are apt to become stenosed by inflammatory swelling, and by retaining the secretions give rise to mastoid empyema. There is usually a radiate or racemose arrangement of the *pneumatic cells* about the antrum, due to the fact that they are outgrowths of the

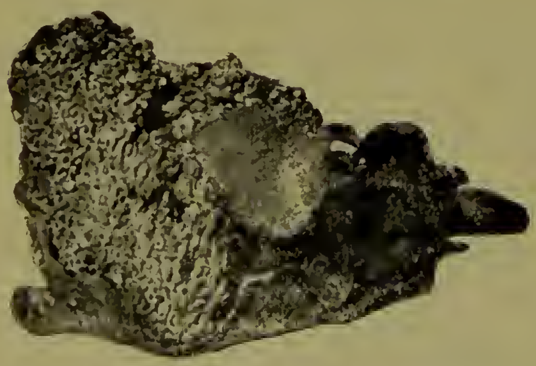


FIG. 453.—Metal cast of very diploëtic mastoid, with pneumatic cells only close about the antrum.

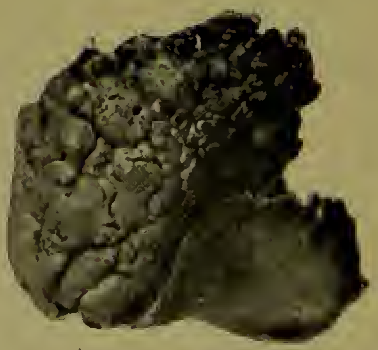


FIG. 454.—Cast of wholly pneumatic mastoid.

tubo-tympanic space. At birth there is merely diploëtic structure of the tiny mastoid and adjacent pyramid; and in the developed bone this may never be wholly displaced (Fig. 453), although probably steadily decreasing as the pneumatic cavities enlarge. Little of it remains in the great majority of adult bones which I have examined (Fig. 454); and study of a thousand indicates that hardly 2 per cent. could be classed as diploëtic, and only some 10 per cent. as combining a notable amount of diploë with the pneumatic spaces. No mastoid is absolutely pneumatic, although some senile bones show a single thin-walled cell occupying the greater part of the process; but no demarcation can be drawn as to how far the air-cavities may be expected to extend. In some specimens they invade the occipital bone backward; they may occupy the zygomatic process and hollow out the pyramid to its very tip anteriorly —usually they pass close to the sigmoid sinus. Some generally connect with the beginning of the Eustachian tube, lying in its floor in close relation to the carotid. Bordering on the digastric fossa, they are thin-walled and large on the mesial as well as on the distal side. The *paramastoid* or *paracondyloid* outgrowth sometimes seen upon the occipital, as well as even the condyle itself, may be occupied by these pneumatic extensions of the tympanum. Their function, if any, is doubtful; and they probably show merely Nature's economy of material and only rarefy these structures within as they grow externally larger. Too utterly variable for the condition on the one side to form much of a criterion for the other, they have no very great surgical importance. Hyperostotic inflammation can solidify the bone with equal promptness whether it be pneumatic or diploëtic—caries is apt to be equally destructive and extensive in each; possibly pyemic extension is less ready from the pneumatic mastoid than when considerable diploë is present. When aural surgery regarded the antrum as merely one of the mastoid cells, the others seemed of little inferior importance; but more precise views of the anatomy and pathology are now dissipating this view. The surgeon, in undertaking to open a mastoid empyema, acts upon the indications as to the location of the pus, whether in the antrum alone, in the mastoid-tip, or throughout the process, and considers the cell-spaces met only as holding out of his way the more important dural structures which he desires to avoid in opening his track—usually to the antrum. His concern is principally that no anomalous forwardness bring the sinus into his field nor undue lowness of the middle fossa expose the dura to unintended attack. He must know that while 10 mm. is the average width of his field, the lateral sinus may wholly occupy it; that above the *spina* there may be none of the 6 mm. of space usually to be expected; and that every bone, whether left or right, in brachycephalic or dolichocephalic, must be treated as though presenting the most dangerous relation possible, until exploration has proved the contrary. Boring instruments must give place, therefore, to gouge and spoon; and the mastoid surface must be bared and well scrutinized, and not blindly attacked even at the well-chosen point. For the antrum this is usually about 5–10 mm. horizontally back of the suprameatal spine, and the cavity should be reached at a depth of 10–15 mm. by a channel parallel to the meatus, but directed slightly more upward. Probably the facial and semicircular canals on the farther side of the antrum are never less than 15 mm. from the mastoid surface; but they are rarely more than 25 mm.—a depth which may be taken as the maximum permissible penetration.

Much important anatomical detail has been here omitted, such as the origin and course of the fibers of the acoustic nerve and their distribution. Those wishing more than is shown in Fig. 441 are referred to the exhaustive works.

THE PHYSIOLOGY OF THE EAR.

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OF CHICAGO, ILL. OF MINNEAPOLIS, MINN.

The physiology of the ear is one of those functional problems the solution of which depends upon the application of physical principles to the operations of the living tissue-cell. It involves, essentially, the translation of physical phenomena into forms of physiological activity. Nevertheless, a clear distinction must be made between the physical laws under which auditory stimuli are conditioned and the physiological laws under which auditory impressions are developed and interpreted.

The production and propagation of sound-waves are governed by these physical laws. Matter, in direct ratio to its elasticity and inversely to its density, is susceptible of vibratory motion. Those forms, phases, or degrees of vibratory motion to which the organs of hearing are responsive are termed sound-waves. The limitations of this term are dependent upon the capacity of the auditory apparatus, and vary, therefore, with the degree of auditory development in the particular species or individual.

Waves of sound may be defined, under these limitations, as the to-and-fro or oscillatory movements of particles of matter, each particle similarly affecting its immediate neighbors, so that alternating condensations and rarefactions of these particles of the sound-transmitting medium are produced. These vibratory movements occur in a direction either longitudinal or transversal to the axis of the propagation of the sound, according to the nature and arrangement of the conducting agent.

Particles of matter which are at similar points of condensation or rarefaction are said to be in the same "phase." The distance between such particles in similar phase is termed the wave-length. This distance—and therefore the wave-length—varies with the velocity of the wave-movement and with the rate of the sound-vibrations—*i. e.* the degree of velocity per second, divided by the number of vibrations per second, gives the measure of a particular wave-length. The velocity of sound-waves is determined by the relative elasticity and density of the transmitting medium.

A wide variance is discovered in the sound-propagating qualities of different media, such as air, water, solids, etc.; but the superiority of a medium as a conductor of sound-waves does not altogether overcome the difficulty of their transference from one medium to another, as from air to water.

The impact of sound-waves upon substances of suitable form and position will cause a reflection of sound; that is, a reprojection of sound-waves of similar character to a distant focus. Echo is an illustration of sound-reflection from a reflector so distant that the primary waves die away before the secondary or return waves reach the ear at the focal point.

Sound-waves, passing through a substance of biconvex form and of greater density than the air, may be refracted, as light is in passing through

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a lens, to a focus in front of the refractive body. The expansion or diffusion of sound-waves is limited in their conveyance through tubular passages, and thus sound may be said to be susceptible of collection.

Sound-waves are possessed of certain physical properties which are the subjects of recognition by the organs of hearing. The accurate analysis of these qualities is dependent upon the degree to which the specialization of auditory function has been carried.

Sound-waves are measured (1) by their *amplitude;* that is, by the energy of the movement of the vibrating particles—by the degree of their excursion upon either side of a position of rest. This property marks the force of the stimulus to which the auditory nerve-terminals are subjected, and, together with the degree of responsive irritability possessed by these terminals, determines the *loudness* or *intensity* of a sound.

Sound-waves are measured (2) by that property which is termed *pitch*—a feature determined by the number of vibrations per second which the particles of the sound-transmitting medium undergo. The range of variability in this vibration-rate possible of appreciation by the human ear is a very wide one, although its limits vary widely with the degree of auditory development. The appreciable extremes of vibration are placed between 24 per second and 40,000 per second,[1] but the more usual limits of discernment are between 33 and 16,000.

Sound-waves are characterized (3) by the presence or absence of rhythm in the recurrence of their vibrations. If the vibrations have a regular periodicity, they are said to give *musical sounds;* if they are of irregular rhythm, they constitute *noises.*

Waves of sound, and particularly of musical sound, are distinguished (4) by their *quality* or timbre, a property which rests upon the fact that they are usually of a compound character—*i. e.* they are associated or consist not of single, but of several, waves. This association is usually of a *fundamental* or dominant *tone,* characteristic of the vibrations of the conducting medium as a whole, with *partial* or over-tones produced by the coincident vibrations at a more rapid rate, and therefore of a higher pitch, of different portions of the conducting medium.

When the vibration-rates of associated tones, whether fundamental or partial, are in the same arithmetical relation as small whole numbers are to each other (*e. g.* as 4 to 5, or as 6 to 8)—that is, when their relationship of rate cannot be expressed in integral multiples—the resultant note is termed a harmonic.

When the vibration-periods of coactive or associated sound-waves are not coincident, or in this relationship of small whole numbers to each other—whether they give rise to fundamental or to over-tones—a phenomenon termed *beat* ensues. The beat is due to an increased intensity of sound whenever the waves are in the same phase—that is, when they are alike in the phase of condensation or alike in the phase of rarefaction—and to an interference with or diminution of the sound when the waves are in opposite phases—that is, the one in rarefaction and the other in condensation.

The number of these beats depends upon the difference in the vibration-rate of the associated waves. When this difference is not great and the beats are therefore few, they are readily appreciated by the ear and do not produce unpleasant effects upon it. As the difference of vibration-rate increases and the beats become more numerous, they introduce a discordant element, and at length (when about 33 per second) they produce a sort of vertigo of the auditory sensations which we translate as *dissonance.* Further increasing in number, the beats become gradually fused and the roughness of sound lessens, until they reach the extreme time-limit of distinct sensations (132 per second) and are lost. So that sound-waves whose vibration-periods are widely different, and which give rise to a very large number of beats very frequently repeated, afford no appreciation of beats whatever to the human ear.

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[1] Blake and others cite the appreciation of tones to 80,000 or more.

Of especial bearing upon the physiology of hearing are the physical principles of sound-selection. Certain substances have a capacity for *sympathetic vibration.* They are inherently endowed with a definite vibration-period, and whenever sound-waves of this particular pitch approach them, they are excited to vibrations in harmony with the stimulating waves, and thus serve to swell the volume of the primary sound. To vibrations of period variant from their own they are dumb. So marked is this tendency to sympathetic vibrations in certain media that they are termed resonators, and the quality which they possess is called *resonance.*

Sympathetic vibration is so acute a quality in some agents—as, for instance, in the strings of a piano-forte—that a complex musical note sounded in their near neighborhood will be resolved into its component tones by their selective power, each string responding to its own intrinsic tone. In this quality lies the foundation of the analysis of sound, unquestionably one of the physico-physiological functions of highly specialized organs of hearing.

These functions of the auditory apparatus will be best understood if the close relationship between physical principles and physiological conditions, which this term implies, is borne in mind.

The Sound-collecting Apparatus.—The external ear, consisting of the pinna and the meatus, has the primary duty of collecting, reflecting, and perhaps, to a degree, resonating the waves of sound. The auricle with its conch-like form and its labyrinthine depressions is essentially a sound-gatherer. In this function it is assisted in some animals, although rarely in man, by a group of muscles—the attollens auriculæ, moving the ear upward; the attrahens auriculæ, drawing it forward and upward; and the retrahens auriculæ, pulling it backward. Slighter alterations in the form of the auricle may be effected by a second group—viz. the tragicus, the antitragicus, the

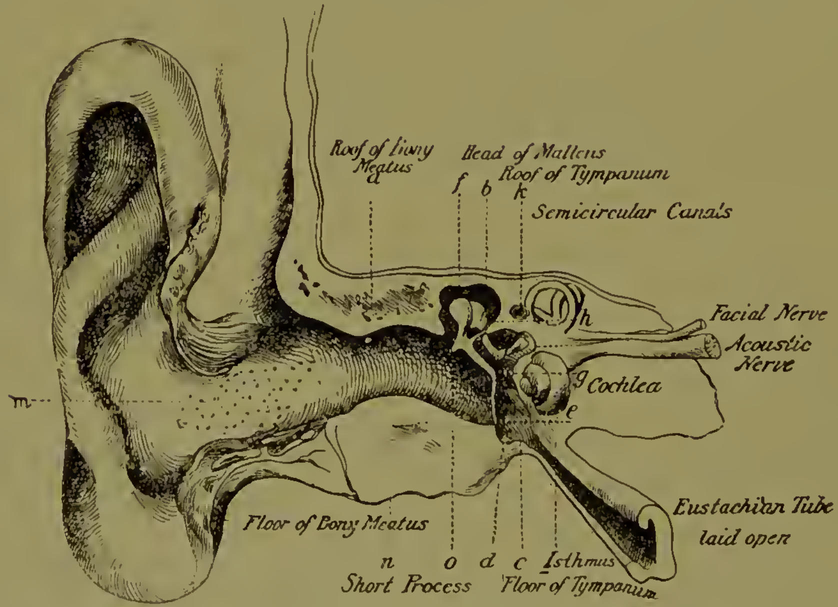

FIG. 455.—Frontal section of the organ of hearing (modified from Politzer).

helices major and minor, the transversus, and the obliquus auriculæ. By the tragus and by means of the curvature of the meatus the drumhead is protected from the too severe impact of powerful vibrations or currents of air, and the canal from the too easy entrance of insects and foreign bodies. The presence of hairs and of the cerumen in the meatus also guards the ear from these invaders.

The position of the tragus and the form of the curvature of the canal also suggest that from the center of the conch sound-waves may be reflected to the inner face of the tragus, from that surface to the roof of the meatus, and thence to the tympanic membrane. The tubular passage of the meatus indicates its sound-collecting and, possibly, its sound-resonating qualities.

The Sound-conducting Apparatus.—The middle ear, including the tympanic membrane, the chain of ossicles, the intratympanic muscles, and the fenestræ ovalis and rotunda, together with the perilymph enclosed by the bony labyrinth of the internal ear, is pre-eminently the organ of sound-conduction. To this function the appendages of the middle ear, the Eustachian tube, the antrum, and the mastoid cells indirectly minister. In the process of conduction the sound-waves which break upon the tympanic membrane are transmuted, through its agency, into a mechanical movement, a molecular vibration, which involves both the chain of ossicles and the perilymph, and is retransmuted, through the medium of the latter, into sound-vibrations in the internal ear.

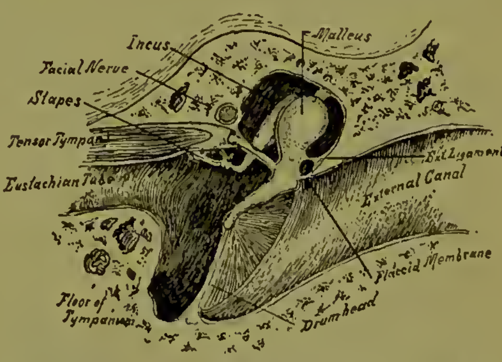

FIG. 456.—Vertical section of the middle ear, drumhead, and external canal, showing the ossicles and tendons of tensor and stapedius.

The tympanic membrane, a small, thin, membranous sheet, tautly stretched across the junction of the external with the middle ear, with its slight irregular convexity, with its radial and circular fibers centering at the *umbo* and giving it a certain fixity of form, with its tensity increased by muscular action, is admirably adapted to its purpose. The longitudinal vibrations of the sound-waves which reach it through the column of air in the external meatus excite in it, as they do in other bodies similarly stretched and whose cross-section is of similarly small dimension, vibrations of a transversal form. Thus the drumhead vibrates inward and outward between the cavities it divides. Through the attachment of the handle of the malleus to its umbo it is not only put into direct relations with the chain of ossicles, but is controlled by the tensor tympani muscle. This muscle, the tendon of which is attached to the upper third of the handle of the malleus, and traverses a portion of the middle meatus, executing around a bony eminence near the Eustachian canal a turn almost at right angles to the body of the muscle, takes its fixed point in a groove running above the lumen of that canal. The contraction of this muscle, controlled by efferent branches of the fifth nerve, serves, in all probability, a double purpose. It draws the malleus inward, and thus increases the tensity of the tympanic membrane, rendering it more acutely responsive to sound-waves of high pitch. It also increases the contact between the handle of the malleus and the drumhead at the umbo, the former serving, in consequence, as a "damper" by which the fundamental tone of the tympanic membrane—which in bodies of such structural form would tend to be over-prominent—may be diminished.

This suggests the fact that the vibrations of this membrane are of a composite character. It is susceptible of simultaneous response to sound-waves having a very wide range of variance both as to pitch and quality.

The Ossicular Chain.—These delicate vibrations of the drumhead are brought to bear upon the chain of ossicles (Fig. 457) through the handle of the malleus. The ossicles—which, taken as a whole and physiologically, must be regarded as a continuous chain—are too minute, in all their dimensions alike, to encourage the theory that they are a medium of sound-conduction by molecular vibration. The shortest of wave-lengths is long as compared with their greatest measurements. Moreover, the mutual arrangement of the malleus, the incus, and the stapes, and their relations to the drumhead at one extremity of the chain and to the oval window at the other, are such as to indicate their performance of an excursion upon the principle of a lever of the second class. A line drawn from the tip of the horizontal process of the incus through the incudo-stapedial joint of the same bone to the end of the handle of the malleus represents this lever (Fig. 458). The handle of the malleus is the point of applied power, begotten by the vibrations of the tympanic membrane; the end of the short process of the incus is the fulcrum, and the incudo-stapedial joint is the point of the effect, which is transmitted through the attached stapes and causes its impact upon the oval window. The unity of this lever is secured by the interlocking of the tooth of the incus with the groove of the malleus. At the same time, the ossicular chain is safeguarded from undue rigidity by the loose capsular ligament attaching the head of the malleus to its articulation with the incus.

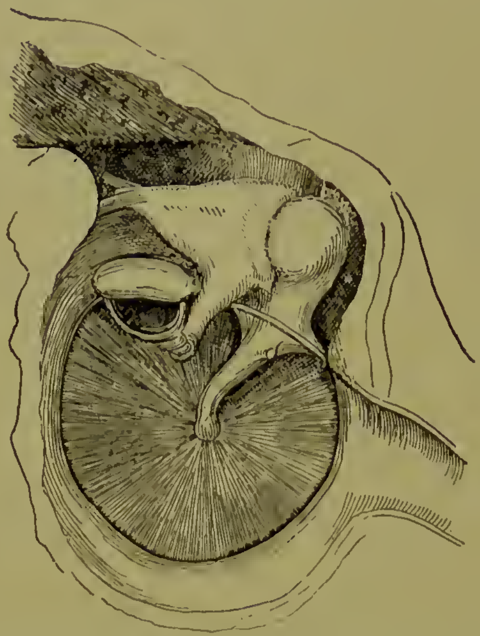

FIG. 457.—Ossicles from within, showing attachment of malleus handle to drumhead, the insertion of the tensor tendon below the chorda, the axis of rotation through the gracilis process and the posterior ligament of the incus, and the tooth of its articulation with the malleus head.

Thus in the event of excessive pressure developed within the middle ear, pushing out the drumhead and carrying the malleus with it, the ossicles no longer act as a whole, since the reversal of the lever would tend to tear the stapes away from the fenestra ovalis. Instead, a separation occurs between the articular surfaces of the malleus and the incus, the head of the former gliding out of its socket and the tooth of the latter tending to unlock. Should this outward movement of the drumhead be so extreme as to carry a part of the head of the malleus back upon the incus again, the point of most forcible contact would again be at the tooth, which would then serve as a fulcrum, converting the ossicles into a lever of the first class and carrying the stapes back again upon the fenestra.

In the ordinary action of this physiological lever the movement of the short arm is materially less than that of the long arm, while the energy of the movement is multiplied two and a half times between the point of its application and the point of its discharge. As Helmholtz states it: "The mechanical problem which the apparatus within the drum of the ear had to solve was to transform a motion of great amplitude and little force, such as impinges on the drumhead, into a motion of small amplitude and great force, such as had to be communicated to the fluid of the labyrinth." Thus a sharp and relatively forcible blow is struck by the stapes upon the oval window. The effect of this blow may be accentuated or diminished by the action of the stapedius muscle. This muscle from its origin in the pyramid in the back wall of the tympanic cavity passes to its insertion upon the capitulum of the stapes. It is efferently controlled by fibers of the seventh nerve. Under ordinary circumstances its contraction draws the foot of the stapes outward toward the drumhead, while the heel is thus brought more sharply into contact with the fenestra. A more forcible contraction, which may be excited reflexly by too powerful vibrations of the tympanic membrane, would tend to draw the whole foot-plate away from the oval window, and would thus diminish the pressure upon the contents of the labyrinth.

Sound-vibrations may reach the middle ear through the bones of the skull instead of by the ordinary path of the meatus, or they may be transferred from one side of the head to the other; but in either case it appears to be true that the tympanic membrane receives these sound-waves and transmits their effects through its own transversal vibrations to the chain of ossicles.

It is possible that to some small degree—and especially in the event of fixity of the ossicles—the air contained in the tympanic cavity may be thrown into vibrations, and that these may affect the perilymph through the oval or round window.

The Appendages of the Middle Ear.—A thin mucoid fluid is secreted by glands imbedded in the submucous lining of the tympanic cavity, or more probably formed by the deliquescence of its effete cells. The ciliated epithelium, which constitutes the mucous membrane of the cavity, excepting upon the surface of the ossicles and the tympanic surface of the drumhead, and is found also in the Eustachian tube, with which the tympanic cavity is continuous, serves to carry the excess of fluid toward and through the tube into the pharynx.

The Eustachian tube has an irregular lumen, and in its lower portion its walls are in somewhat loose contact, and appear to be, as a usual thing, closed. The tube opens for the discharge of the mucous secretion of the middle ear into the pharynx; it is opened also during the act of deglutition, when air finds its way into the middle ear. Its most important and, perhaps its sole, functions are thus to drain the tympanic cavity and to preserve an equilibrium of pressure between the gaseous contents of the cavity and the atmosphere. Should the contained gases become absorbed and the tube be impermeable, a vacuum results which may cause retraction of the drumhead and disease of the intratympanic tissues. The opening of the tube during acts of deglutition is sufficient, as a rule, to maintain this equilibrium of intratympanic and extratympanic pressure.

The antrum and the mastoid cells are, physiologically, extensions of the tympanic cavity, although their communications with that cavity are not always patent. Their functions are still a matter of conjecture. They probably serve as pneumatic spaces within which a supply of air may be retained as an additional means of maintaining the air-pressure within the tympanum. They have been supposed also to serve as diffusion-chambers for excessive sound-vibrations, which may be communicated to the air in the tympanic cavity, and which might otherwise fall with undue energy upon the windows of the labyrinth. There is little evidence, however, in support of this view, since sound-waves, within ordinarily wide limits, and whether conveyed through the external meatus or through the bones of the head, are transmitted to the tympanic membrane, and, centering at the umbo, are forwarded through the movements of the ossicular chain rather than through the air of the cavity.

The Bony Labyrinth and the Perilymph.—By means of the fenestra ovalis and the fenestra rotunda, the windows of the bony labyrinth, increase and decrease of pressure in the perilymph are provided for. The influence of the sound-vibrations of the drumhead, through what may be called the sound-movement of the ossicles, is conveyed to the perilymph by the impact of the stapes upon the membrane which curtains the oval window and divides the tympanic cavity from the vestibule. The shock which is thus transmitted to the fluid of the bony labyrinth follows the course of its cavity, and is finally expended upon the membrane of the round window, which curtains the cochlear canal from the middle ear. Thus in the round window a safety-valve is afforded for any excess of pressure.

What has been said of the chain of ossicles with reference to their insusceptibility to molecular vibrations is equally true of the perilymph, enclosed as it is in a bony cavity of minute dimensions, of labyrinthine form, and with resistant walls. The impact of the stapes upon the oval window produces, not waves of sound travelling through the particles of this fluid, but a wave-movement which involves the perilymph as a whole. So difficult is the transference of sound-vibrations from one kind of medium to another, that the vibratory movement of the perilymph more readily develops sound-waves in the walls of the membranous labyrinth than would a series of molecular vibrations passing through the particles of this fluid. Such a movement has, in fact, an advantage over sound-vibrations of the molecular form as a means of communicating to the sensitive structures of the internal ear the influence of the sound-waves which break upon the drumhead.

The Sound-recording Apparatus.—The utricle, the semicircular canals, the saccule, and the cochlear canal make up the membranous labyrinth, enclosing the endolymph and surrounded by the perilymph within its bony sac. These organs are concerned not merely with the receipt of auditory impressions in general, but with the analysis and synthesis of sound. The impressions which they record are destined for the development of auditory sensations, which, in their turn, give rise to auditory perceptions and judgments relating to intensity, rhythm, pitch, quality, distance, location, etc. The part which each portion of the membranous labyrinth plays in the attainment of these physiological ends is not yet sufficiently well worked out to justify much in the way of precise statement. Certain propositions may be established, however, with some measure of confidence, and these form the basis for certain safe conclusions.

The principles of sound-conduction indicate that the walls of the membranous labyrinth, with their fibrous structure, are a better medium for the development and transmission of sound-waves, as the result of the impact of the perilymph upon them, than the endolymph contained within these membranous walls can possibly be. The endolymph is a viscid fluid whose density would prove an obstacle to acute vibratory motion. In variable quantity it bathes the specialized auditory epithelium of the cristæ, the maculæ, and the cochlear spiral (Fig. 458). From its contact with a highly vascular membrane, the stria vascularis, from its identity with the cerebral fluid and the continuity of its channels with those of the brain, from its homology with nutrient fluids in other localities, it may fairly be considered as an agent of nutrition to these epithelial cells, rather than as a medium through which sound-waves are conveyed to them. A difficulty, too, and a quite unnecessary one, is involved in the idea of the transmission of vibrations through the walls of the membranous labyrinth to a medium of so markedly different a character and vibratory quality as the endolymph.

It would seem that the auditory epithelium resting upon the inner surface of these membranous walls must be more readily affected by sound-vibrations directly transmitted to it from beneath than by vibratory movements in the endolymph above (Fig. 459).

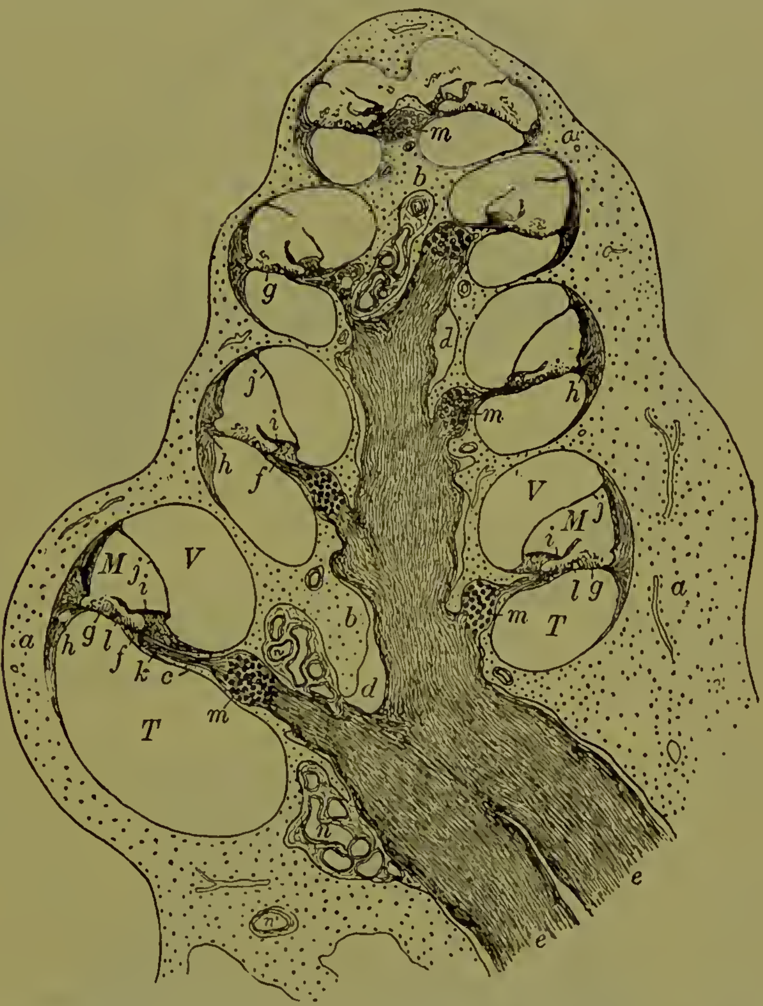

FIG. 458.—Section of guinea-pig's cochlea, with its scala media (M) winding from base to apex between the vestibular (V) and tympanic (T) scalæ (Piersol).

The peculiar form of the bony labyrinth, as related to the points at which the sweep of the perilymph begins and ends—viz. at the two fenestræ—indicates that the force of the movement of the perilymph is probably conveyed across the membranous labyrinth, and bears strongly upon the ampullæ, the utricle and saccule, and the walls of the cochlear canal.

The functions of the internal ear are of a more varied character than is suggested by the general term auditory impressions. There are reasons, still under debate, but perhaps sufficiently conclusive, for regarding the semicircular canals, or the terminals of the vestibular nerve in their cristæ, as well as in the maculæ of the utricle and saccule, as the source of afferent impressions which assist in the preservation of both static and dynamic equilibrium.[1] Whether these impressions arise from the movements of the endolymph within the semi-circular canals, and are therefore dependent upon position, or whether they are the effect of vibrations transmitted through the walls of the ampullæ to the vestibular terminals, is a question still *sub judice;* but there remains little doubt that these terminals are, in one way or the other, concerned in the development of equilibriar impressions. The presence of the so-called otoliths or otoconia in the walls of the labyrinth has given rise to the suggestion that they are concerned in the causation of these impressions. Recent experiments tend, however, to prove that the vestibular portion of the labyrinth is not, in an exclusive sense, an organ of equilibration. It is simply an afferent field from which the centers of co-ordination receive a certain measure of instruction.[2] In the event of its injury or removal, leading to temporary symptoms of vertigo, compensatory phenomena have been developed, which, in their readiness of appearance and their measure of substitutive function, are in direct ratio to the degree of cerebral development.[3] One distinct phase of the equilibriar functions of the internal ear is observed in its afferent regulation of compensatory movements in the eyeball.[4] But while the evidence holds good that the auditory epithelium and the nerve-terminals of the cristæ and the maculæ are the recipients of other than purely auditory impressions, it is not necessary to dissociate the equilibriar from the auditory functions of the vestibule, or to consider it

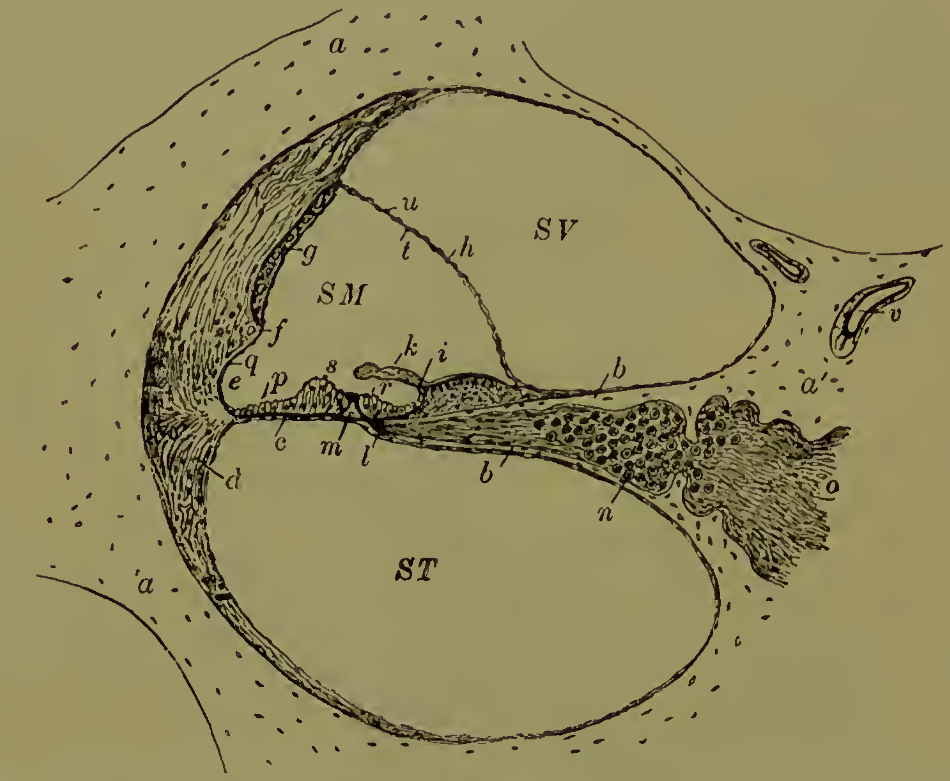

FIG. 459.—Transverse section of a lower turn of the cochlea, showing the structure and relations of the cochlear canal, *SM* (Piersol).

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[1] Howell: *American Text-Book of Physiology.*
[2] Fano and Marini: *Sperimentale,* Parts 5 and 6, 1893.
[3] Ewald: *Pfluger's Archiv,* lx. p. 492.
[4] Crum-Brown: *Lancet,* May 28, 1895.

exempt from auditory duties. The fact that this organ is of some physiological service in co-ordinating the movements of the body does not even argue a separative function for this purpose. The sense of equilibrium is not wholly independent of the sense of hearing. Loud or peculiarly harsh noises, and those extreme disturbances of rhythm which are incident to the occurrence of numerous beats in musical sounds, often beget sensations of a vertiginous character. Extremely deaf persons have a characteristic uncertainty of gait, which in deaf-mutes often amounts to actual insecurity. Forty per cent. of the unfortunates of this class who have been examined have been found faulty in co-ordination.[1] An absence of nystagmus is frequently observed in such persons (Crum-Brown). While these facts do not conclusively prove the interdependence of equilibriar and auditory functions, they suggest a very close relationship between them.

Furthermore, the absence of the cochlea or its very rudimentary form in certain animals who possess the sense of hearing to a marked degree, compels the recognition of the vestibular portion of the internal ear as a receiver of auditory stimuli of at least certain kinds. Conversely, the form and the arrangement of the cochlea (Fig. 460) indicate unmistakably that it is an organ of sound-analysis and perhaps of sound-synthesis, but do not offer equally good evidence of its capacity to develop those auditory impressions which create sensations and judgments relating to intensity, rhythm, dissonance, etc.

It is altogether probable that the auditory epithelium and the nerve-terminals of the maculæ, and perhaps of the cristæ, are the media by which are appreciated those qualities which pertain to so-called *noises*, and which establish the differentiation between rhythmic and arhythmic sounds (Howell). It is, in fact, these primary auditory functions with which those animals are conspicuously endowed who have only the vestibular portions of the internal ear, while we have little or no evidence that they are possessed of the faculties of sound-analysis and synthesis.

These most highly specialized of auditory functions by which the variations in pitch and quality of sound-waves are recognized, by which composite notes are resolved into their component tones, and by which individual tones are fused into complex sensations, are unquestionably possessed by the cochlea.

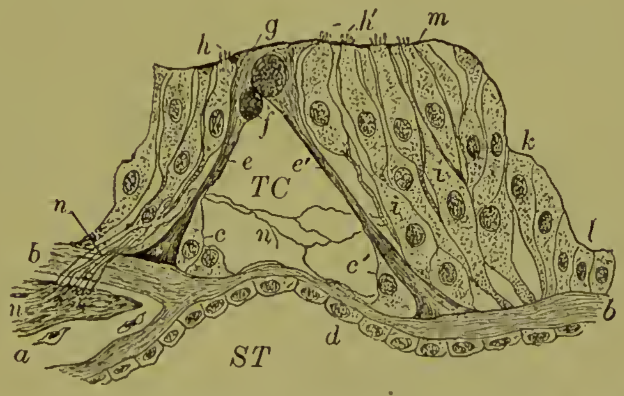

FIG. 460.—Corti's organ, showing the inner (*h*) and outer (*k*) hair-cells, the supporting pillars (*f*, *g*), and basilar membrane (*b*) (Piersol).

In the basilar membrane (Fig. 460), upon which the organ of Corti rests, is found the only structure in the highly developed ear which satisfactorily accounts for the faculty of tone-selection. Although in man it is of small dimensions as a whole, its radial tensity, together with its longitudinal laxity, the sufficiently wide range of difference in the radial lengths of its fibers, and the number of these radial fibers, estimated at 24,000, are qualities which suggest its vibratory function and endow it with ample possibilities of selective vibration. By selective or sympathetic vibration is meant the possession by its individual fibers of intrinsic pitch, in consequence of which each will vibrate only in harmony with a sound-wave whose vibration-period is identical with its own.

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[1] Bruck: *Archiv f. d. ges. Physiol.*, vol. lix. p. 16.

To the rods and cells of the organ of Corti these vibrations are certainly transmitted; in them they are intensified perhaps, and by them are conveyed as impressions of sound to the terminals of the auditory nerve. Physiology has not yet gone so far as to differentiate the several functions of the rods, 9450 in number, of the inner and outer hair-cells, numbering 15,500 (Howell), of the twin-cells of Deiters, or of the cells of Hensen and of Claudius, which all enter into the delicate structure of this organ. They are doubtless the media of communication between the basilar membrane and the terminals of the auditory nerve, but they are probably far more than this. Their structure and mutual arrangement suggest a mechanism for the execution of vibrations of rapid period or high pitch, and for the differentiation of varying vibration-rates. They may serve not only as a means of analyzing composite sound-waves, but as a means of synthesizing complex auditory impressions.

In the tectorial membrane exists, seemingly, a physiological "damper" by which excessive vibrations or too dominant tones are diminished. While it is difficult to demonstrate its possession of this function, its form, situation, and relations to the organ of Corti and to the overarching membrane of Reissner justify the conclusion. Excessive wave-movements within the vestibular scala would necessarily bear upon the stretched membrane of Reissner, and would subject the endolymph beneath it to a pressure which, operating upon the upper surface of the tectorial membrane, would depress its free extremity toward or upon the delicate hair-cells which it surmounts.

That such highly elaborated functions as these attributed to the organ of Corti exist in the human ear is predicated on the remarkable development of many individuals in the faculties of sound-analysis and synthesis—faculties which, while resting lastly upon the possession of specialized nerve-centers which develop sensations and beget auditory perceptions and judgments, must needs require some mechanism upon which the sound-waves may be registered and in which these varying auditory impressions arise.

The Mechanisms of Auditory Sensation, Perception, and Judgment.—The specialized auditory epithelia of the cochlea, the maculæ, and the cristæ are the media of communication between the recording apparatus of the ear and the terminations of the auditory nerve.

There is neither satisfactory evidence nor physiological analogy in support of the theory that auditory impressions are developed elsewhere than in these nerve-terminals or conveyed to the nerve-centers by other than auditory nerve-paths. The apparent reaction to high notes or to loud low tones which has been observed in animals which have been deprived of the membranous labyrinth is doubtless a matter of general sensation rather than audition (Bernstein).

In view of the varied character and location of the auditory epithelium, and the finely specialized quality of these nerve-terminals, it cannot be doubted that they, in common with other special-sense nerve-endings, have a selective action upon auditory stimuli. They must have something to do with determining the nature of the impression which a given stimulus excites. Conversely, their responses must be conditioned, as are those of other nerve-terminals, by the character and the mode of application of the stimulus.

Not only with the recognition of the qualities of intensity, periodicity, and pitch, but with the fixation of the limits of this recognition, they must be partially concerned. That such limits of function exist has been clearly shown. Fatigue-phenomena, incident to excessive intensity, too rapid repetitions, and extremes of vibration in sound are shared by the auditory terminals. Wundt[1] has successfully disputed the doctrine of the specific nerve-energy of the conducting fibers of the auditory nerve; but to carry this contention down to a denial of the specific functions of the terminals would be a physiological *reductio ad absurdum,* since it would deny all utility to the highly differentiated structural forms of these receiving cells.

The degree of irritability manifested by the auditory terminals varies physiologically with hereditary conditions, age, training, and functional fatigue. An illustration of this variation with age is seen in the marked contraction of the compass of the human hearing incident to advanced years.[2]

The specific functions of the nerve-centers of the bulb, of the basal ganglia, and of the cortex, which are in anatomical relations with the fibers of the cochlear and vestibular branches of the auditory nerve, are not, as yet, well understood. The fact that a portion of the vestibular division is traceable to the cerebellum re-emphasizes the probability of an equilibriar function in the vestibule. The deep centers of the bulb and of the lateral nucleus, to which the cochlear and vestibular nerves are primarily traced, are possibly of purely trophic function.

The decussation of the auditory fibers in large part, by which the trapezoid bodies are formed, is suggestive of a fusion of the binaural auditory impressions in the nerve-centers of the two sides—an event which Schäfer, however, denies.

In the posterior quadrigeminal body and the internal geniculate body we find evidence of the existence of auditory centers to which the major portion of the auditory fibers pass from the olivary body through the fillet. These are, clearly, the seats of auditory sensation. In this localization there is a striking homology to the visual sensory centers of the anterior quadrigeminal body.[3] The posterior nucleus of the thalamus is possibly involved also in the registration of sensations of hearing.[4]

Of the manner in which auditory sensations are developed in response to a varied range of auditory impressions but little can be said at present. It is unlikely that each vibration-wave which produces an impression upon the nerve-terminals is represented by a separate and distinct sensation. In all probability, certain fusions of sound-wave impressions are received by the nerve-endings, having been synthesized perhaps in the cochlea, and these are translated into composite primary sensations analogous to the primary visual impulses, and then out of these integers of sensation, as it were, other and more complex sensory groups are developed. These centers are susceptible of an increase of irritability dependent upon stimulation. By the receipt of an impression, or perhaps of a series of similar impressions, the auditory centers are awakened to the appreciation of a succeeding and dissimilar impression. With the binaural conduction of sound there appears to be an alternating centric increase of sensation upon the two sides.[1]

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[1] *Philos. Studien,* vol. viii.

[2] Zwaardemaker: *Archives of Otology,* July, 1894. Partly ascribable, probably, to changes in the conducting apparatus.

[3] Starr: *Atlas of Nerve-cells.*

[4] *Ibid.*

There is not only a close homology, but a functional relationship, between the auditory and the visual centers of the quadrigemina. Acoustic stimulation of the posterior body leads to a quite apparent increase of irritability in the cells of the anterior body, and to such a degree that more distinct visual sensations, especially in the color-field, are induced.[2]

The functions of sound-perception, of auditory judgment, and of auditory memory are localized in the cerebral cortex. In a portion of the first and second temporal convolutions lying ventral to the Sylvian fissure, and in direct communication with the auditory sensation-centers of the basal ganglia[3] by fiber-tracts which pass in both directions,[4] lie the centers which constitute the auditory brain.

These cortical functions have to do with the analysis and synthesis of sound, with the recognition of rhythm, with the determination of distance, and sound-location, and with the recollection and re-creation of sounds previously registered. The remarkable development of the faculties of sound-analysis and synthesis in certain individuals predicates a high order of specialization in this seat of the musical mind. The judgments of sound-distance and location are largely instructed by a comparison of the sensations begotten of impressions made, simultaneously or alternatingly, upon the two sides. In the estimate of distance the intensity of a sound is a governing and an often misleading guide. Thus a low, feeble sound produced in the near neighborhood will often convey the impression of distance, and *vice versâ.* In making up the judgment of distance it is not so much the total intensity as the intensity of the component elements of a sound which gives the most correct conclusions (Bloch).

The location of a sound is almost wholly dependent upon binaural hearing. Bloch has shown that it is more readily determined in the horizontal and frontal planes than in the sagittal plane. A comparison by the nerve-centers of the several characteristics of intensity, continuance, pitch, and quality in the sounds received by the organs of hearing upon the two sides is the major factor in the case. The degree of sound-collection achieved by the two auricles is a minor influence in informing the judgment of the locality of a sound.

The function of sound-memory is but imperfectly developed in the majority of persons, while in a very few individuals it reaches a high degree of perfection. The existence of a memory-center for auditory perceptions, apart from the temporal centers of sound-perception and judgment, is undemonstrated.

Any tendency to dogmatic statement in regard to the specific functions of auditory centers is arrested by the promise of new light which is suggested by the recent investigations of Kölliker, v. Lenhossék, and Held into the origins of the auditory nerve-fibers, and by the late demonstration by Ramón y Cajal of a new auditory nucleus in front of the convexity of the upper olivary body.

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[1] Bloch: *Archives of Otol.,* xxiv. 2.

[2] Epstein: *Zeitschr. f. Biol.,* xxxiii. N. F., B. XV.

[3] Starr: *Op. cit.*

[4] C. v. Monakow: *Archiv f. Psychiatrie,* Bd. xxvii.

ETIOLOGY AND PATHOLOGY.

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ETIOLOGY.

Age.—Infancy and childhood, the latter of which we shall consider as ending at fifteen years, furnish relatively a much larger percentage of ear-affections than youth and adult life. In childhood there is greater tendency to purulent inflammation, while later the chronic catarrhal form predominates. The percentage of ear-affections in childhood, as given by different authors, varies considerably: Bezold found it to be 23 per cent., while Hesse puts it at 43 per cent. Difference in locality, climate, altitude, etc. must naturally produce diverse results in affections so readily influenced by external surroundings.

Heredity plays an important part in ear-affections: especially is one impressed with this when examining the reports of our deaf-mute institutes, where 25 per cent. or more are so attributed. From extensive observations, however, I am satisfied that quite a number of these cases are not congenital, but acquire deafness during the first and second years of life as a result of adenoids, which cause inflammation and hyperplasia, with extension to the middle and internal ear.

Predisposition.—The transmission from parent to child of a predisposition to catarrhal or purulent inflammations of the mucous membranes in general, and of those lining the cavities of the middle ear, nose, and pharynx in particular, while first recognized and most ably described by v. Tröltsch, has not as yet received the attention due its importance; for by an early recognition of this the physician may by prophylactics, such as early treatment, removal of adenoids and hypertrophied tonsils, favorable climatic influences, etc., limit or entirely prevent the development of ear-affections.

Anatomical development is an important factor in predisposition to ear-affections: deep niches in which are set the round and oval windows, unusual development of the promontory, extra thickness of the tegmen tympani, and general reduction in the size of the attic necessarily favor adhesions and deafness after inflammation.

Sex.—Up to the twelfth year the percentage of aural diseases is about equally divided between the sexes, but in youth and adult life men are more frequently affected than women, which may readily be accounted for by intemperance, excessive use of tobacco, and greater amount of exposure to wet and cold.

Bürkner found, from statistics of nearly 100,000 ear-patients of various observers, that in 24.44 per cent. the disease involved the external ear, in 68.52 per cent., the middle ear and tympanic membrane, in 7.04 per cent., the internal ear.

Seasons.—Winter and spring, the seasons when pneumonia is most prevalent, furnish about 66 per cent. of acute middle-ear affections. While bacteriology has proven that "catching cold" is not so frequent a cause as formerly supposed, yet the fact still remains that it predisposes through vasomotor disturbances, paralyzing the action of the ciliated epithelium, etc., and causing secretions favorable to the development of bacteria. Violent and rapidly developing middle-ear inflammations are frequently due to imprudent exposure when overheated, to drafts, standing with thin-soled shoes on damp and cold earth or stones, etc. Chronic catarrh involving the ear is perhaps always associated with a similar condition of the naso-pharynx.

Injuries.—Injuries are either followed directly by ear-affections or predispose to them. Those of the external ear are least dangerous, rarely leading to permanent defect. Bruises of the auricle, as from a blow, may cause hematoma and resulting deformity; injuries supplemented by infection directly to the external meatus lead to localized or diffused inflammation, which may extend to the membrana tympani and middle ear, with extensive destruction. Rupture of the tympanic membrane may result from direct injury, such as clumsy efforts at the removal of foreign bodies from the meatus; also from violent explosions, or a blow upon the ear with the open hand, causing sudden condensation of the air in the external meatus.

Injuries involving the base of the skull generally extend to the inner and middle ear, with rupture of the tympanic membrane—although the latter may not rupture, and may prevent the escape of blood and cerebrospinal fluid. The line of fracture runs usually either transversely or parallel to the long axis of the petrous portion. In a specimen in my collection, taken from a man fifty years of age who fell from a high scaffold, there are extensive fractures at the base, involving both temporal bones, with hemorrhage into both tympanic cavities. The right temporal bone has a fracture extending from the orifice of the internal carotid between the foramen spinosum and hiatus Fallopii, passing outward through the Eustachian tube and anterior portion of the tympanic cavity. Another irregular fracture runs at right angles to the first, passing through the apex of the petrous bone and through the canal of the internal carotid, immediately internal to the internal auditory meatus, down to, but not opening, the jugular bulb; and yet *both tympanic membranes are intact and normal.* Where death does not result from the primary injury, inflammation and suppuration have frequently followed, which I believe to be largely due to subsequent infection in examining or treating the parts with non-aseptic instruments.

Occupations involving much noise, such as those of boiler-makers, coppersmiths, machinists, locomotive engineers and firemen, etc., often cause deafness. Aeronauts and divers at times suffer from tinnitus, dizziness, and deafness due to hemorrhages into the labyrinth, tympanum, or meatus.

GENERAL DISEASES AND AFFECTIONS OF SPECIAL ORGANS, AND THEIR INFLUENCE UPON HEARING.

Nervous System.—Hemorrhagic pachymeningitis may cause sudden loss of hearing through extensive hemorrhage into the internal ear; or repeated small hemorrhages may take place, with resulting nerve-degeneration and progressive loss of hearing, until total deafness results, associated with various noises, hallucinations and dizziness. According to Moos, the disturbance of hearing in multiple cerebral sclerosis in all probability results from sclerotic degeneration of the nucleus and trunk of the eighth nerve.

Cerebral tumors may indirectly cause disturbance of hearing. The interesting experiments of Gellé, Berthold, and Baratoux demonstrated that cutting of the trunk of the trigeminus led to inflammatory symptoms, hyperemia, and exudation of pus in the middle ear. Kirschner also demonstrated that *irritation* of the fifth caused increased secretion of mucus in the middle ear. Gradenigo has proven that with increased intracranial pressure we may have changes of the acusticus similar to those observed in choked disk. Ladame and Bernhardt found that disturbance of hearing as a result of tumors of the pons occurs in about 27 per cent., and, as a rule, on one side only. Tumors of the cerebellum may cause disturbance of hearing on the side affected, opposite, or both sides. Ladame found disturbance of hearing in 9 per cent. In cases where tumors of the corpora quadrigemina existed Bernhardt found the ears involved 4 times in 11 cases, or 36.36+ per cent.; in 2 total deafness, in 1 subjective noises, and in 1 case noises and partial deafness. In tumors of the base the disturbance is seldom limited to any individual nerve, because of the close proximity of the origin of all the cranial nerves; the eighth is involved in about one-third of the cases, while the optic nerve is more frequently affected than any of the others. Tumors involving the eighth nerve are sarcoma, neuroma, glioma, gummata, tubercular nodules, psammoma, and fibroma (see p. 769).

General Symptoms.—It is difficult to make a diagnosis of brain-tumors from aural symptoms alone, especially if we find disease existing in the middle or internal ear; but subjective noises, dizziness, unsteady gait, partial or total deafness affecting one or both sides or crossed, are important aids.

Tischkow has demonstrated that in progressive paralysis there is a formation of new blood-vessels in the cartilage of the ear, growing into it from the perichondrium: it is from these easily ruptured vessels that the hemorrhages take place in hematoma.

Epilepsy and hysteria have each some influence upon the ear, but as yet the results and conclusions are too much at variance to follow up the finely-spun theories in the brief space of this article.

Respiratory Organs, and their Relation to Ear-affections.—The respiratory organs are by far the most important causative factors in inflammations of the ear. Bürkner found 22.6 per cent. of acute middle-ear catarrh and 26 per cent. of the chronic variety ascribed to cold in the head. Nasal and pharyngeal catarrh is responsible, according to various authors, for from 33 per cent. to 60 per cent. of ear-affections. My belief, based upon a careful investigation of this point, is that the higher percentages are more nearly correct. We are daily more forcibly impressed with the great importance of the above-named disease as a cause of ear-affections. Pertussis, hay-fever, measles, etc. have their influence on account of the extension of catarrhal inflammation to the middle ear. Hemorrhages into the ear can occur as a result of whooping-cough.

Vascular System.—Atheromatous changes not infrequently cause subjective noises in the ears, which are constant and increased by circulatory disturbances. Where there is no other middle-ear affection, hearing is, as a rule, normal in this class of cases.

Many aural inflammations are ascribed to dentition with as much probability as the concurrent intestinal involvement; and others are doubtless influenced by dental irritation.

Nephritis, whether interstitial or parenchymatous, frequently leads to disturbances of hearing. Doumergue found it in 35 per cent. The symptoms vary from subjective noises to partial and total deafness, either one or both sides becoming affected, the causes being hemorrhages, inflammatory changes of the mucous membrane, or pressure from edema, while the purely nervous manifestations can be caused by the uremic poisons. The subjective symptoms and the hearing often improve temporarily after the elimination of poisonous products and the reduction of arterial tension and edema by medication.

Sexual Organs.—Disturbance of menstruation, especially its cessation, influences the ears. Levy reports a typical case of complete deafness on both sides after cessation of the menses, without any other symptoms. Upon return of menstruation, three months later, hearing was completely restored.

Hemorrhage from the ear (vicarious menstruation) can also occur with or without perforation of the membrana tympani and without existing inflammatory symptoms. In the unperforated cases the hemorrhage comes from the surface of the membrana tympani and external meatus (probably out of ceruminous glands) (Gradenigo).

General Conditions.—Rachitic children are frequently affected with ear-disease, which is probably due to malnutrition and catarrhal predisposition. Eitelberg examined both ears of 250 children belonging to this class, and of the 500 tympanic membranes only 39 were normal.[1]

Gouty deposits are, according to Garrod, more frequently found in the ear than in any other organ. These deposits vary in size from a pinhead to half a pea, of pear-like appearance, generally located in the folds of the auricle, hard or soft, and contain a milky or creamy fluid. Victims of this disease generally suffer lancinating pains in the ear before and during a gouty attack. Gout predisposes to the formation of exostoses of the external meatus, and these are found more frequently among the English than any other nationality.

Eczema, hemorrhage, purulent inflammation, and rapid necrosis of the temporal bones are encountered as a result of diabetes: the rapid destruction is accounted for by the lowered resisting power of the tissues, combined with extensive arterial sclerosis. This explains why in these cases violent mastoiditis can rapidly develop from a simple naso-pharyngeal catarrh. The arterial changes favor excessive hemorrhages—a fact to be remembered when operating. The diplococcus of pneumonia is often found in the acute purulent secretion of these cases, and is generally associated with the streptococcus pyogenes and staphylococcus pyogenes albus. Habermann demonstrated the staphylococcus pyogenes aureus in the walls of the blood-vessels; the resulting toxin may lead to necrosis of the vessel-wall and hemorrhage.

Caries of the teeth not infrequently causes otalgia, either constant or intermittent. The pain may radiate to the ear, shoulder, and from there to the fingers of the affected side (Urbantschitsch).

Acute and Chronic Infectious Diseases.—Bacteriological studies of the effect of acute and chronic infectious diseases upon the ear have during recent years been pursued with much energy by many able investigators. The principal bacteria which so far have been studied as causative factors of inflammation of the ear are—

a. The diplococcus of pneumonia;
b. Staphylococcus pyogenes albus and aureus;
c. Streptococcus pyogenes;
d. Bacillus pyocyaneus.

Each may be found alone or two or more varieties (mixed forms) may be found at the same time, making it impossible to state which is the primary causative agent.

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[1] Four hundred boys, generally healthy and athletic, in a Philadelphia school, showed hardly two dozen normal drumheads.—Ed.

Pathogenic Germs.—The various streptococci are divided into two main groups—streptococcus brevis and longus: the first is non-pathogenetic (saprophyte); the second is virulent, and may be found in the different inflammatory processes. Furuncles of the external meatus can be caused by any of the staphylococci, although the staphylococcus aureus is the most frequent cause, gaining an entrance by the hair-shafts. The middle ear may, according to the cause and character of the inflammation, harbor any of the above-named varieties. In inflammation of the internal ear we find principally the streptococcus.

Avenues of Infection.—There are several paths by which the micro-organisms may enter the ear:

1. Through the Eustachian tube;
2. Through the external meatus and perforated membrana tympani;
3. Through the dural process in the petro-squamous fissure;
4. Through the lymph- and blood-vessels.

While the Eustachian tube is the most frequent avenue for the bacteria to enter, nature has provided an important barrier against invasion from the nose and pharynx in the ciliated epithelium, *whose motion is from the tympanic cavity toward the pharynx;* it is when this epithelium is rendered defective by pathological changes that the exciting cause may enter. The main defence against bacterial invasion is a perfectly healthy organism. Infection of the internal ear occurs most frequently through the lymphatics, especially those of the periosteum.

The character of the inflammation, whether catarrhal or purulent, active or passive, depends largely upon the virulence and number of the invading bacteria and the resisting power of the invaded mucous membrane. If the bacteria enter in small numbers and slowly, they may cause only an irritation with lymph-exudation, division of the lymph-nuclei, but not of the protoplasm (Moos), formation of giant-cells, blood-vessels, connective and even osseous tissue. If, however, they enter suddenly in large numbers, then the resulting disturbance of nutrition causes a rapid breaking down of the parts; reaction may begin and new tissue develop, resulting in hyperplasia and partial or total obliteration of the original anatomical relations.

Whether the disease shall promptly run its course or change into the chronic form depends upon the continued activity of the germs present or upon the gradual dying out of the first culture, and implantation of new varieties upon the now affected membrane. The general health is often impaired by previous disease and permits only slow restoration. We also find, especially in measles and diphtheria, that there are extensive changes in the endothelium of the blood-vessels—fatty degeneration and thrombosis, with necrosis of the vessel-walls, resulting hemorrhages, and extensive or total loss of hearing. Minute capillary hemorrhages may also result, causing the death of a limited area only of the nerve-tissues, with temporary or permanent *partial* deafness.

Diphtheria and Scarlet Fever.—Bürkner found acute otitis media purulenta resulting in 1.5 per cent. of all cases of primary diphtheria of the pharynx, and nerve-deafness in 7 per cent. The ear is, however, more frequently involved in diphtheria than would appear from statistics, because in fatal cases of diphtheria (average duration six days) death results before the ear-affection has become fully developed. The authorities nearly all agree that purulent otitis media results in about 5 per cent. of all scarlet-fever cases. Bezold found in 185 cases of purulent otitis media from scarlet fever 30 times total destruction of the tympanic membrane, with loss of one or more ossicles, and 59 times destruction of at least two-thirds of the membrane.

The author found, in an examination of 500 children at the Institute for Deaf-mutes in Jacksonville, Ill., that their deafness was ascribed to scarlet fever in 7.2 per cent. and to diphtheria in 0.8 per cent.

The rapidity with which destruction may result to the ear from diphtheria is almost incomprehensible. Where death has occurred sixty to seventy-two hours after the beginning of the disease the microscopic examination of the middle and internal ear has revealed numerous micrococci, not alone in the blood-vessels, but also in the deeper layers of the mucous membrane and in the lacunæ of the *adjoining bone*, often leading to extensive or circumscribed necrosis.

In **measles** we find that while the ears are frequently involved, there is much less tendency to extensive destruction than in diphtheria or scarlet fever, the disease rarely going beyond an acute catarrh. Solomonson found deaf-mutism caused by measles in 5.6 per cent., Hartmann, 3.6 per cent. Tobeitz found otitis media in 21.9 per cent. in *convalescent* children. Of 22 children dying from measles, the ears of 17 were examined post-mortem, *and in every one the mucous membrane of the middle ear was found to be diseased, although in only 7 of them had there been any clinical manifestation of ear-complication.*

Typhoid fever is at times accompanied by aural inflammation varying from a slight catarrhal to a violent purulent form. This is, however, often overshadowed by the severity of other symptoms, and not noticed until convalescence has begun. The severe deafness at times present may be due to weakness of the nerve-centers, and in a few cases to changes in the labyrinth: mastoiditis may also occur; while with parotid suppuration discharge of pus into the external meatus is not an infrequent occurrence.

Cerebral Origin.—Disturbance of hearing of cerebral origin is frequent, and includes a wide range of manifestations, which may be caused by morbid processes of the brain or its membranes, but most frequently by involvement of the internal ear. By far the largest number are found as sequelæ to cerebro-spinal meningitis: according to Knapp and Moos, the deafness develops in most cases in the first or second week.

The percentage of cases where the ears are involved in cerebro-spinal meningitis varies greatly in different epidemics. Competent observers have reported *on epidemics where disturbance of hearing seldom occurred, while in others nearly all who recovered were deaf.* In Ziemssen's Handbuch Dr. Roth reported that from the district of Oberfrank, with 55,000 inhabitants, there were during a period of two years 58 cases sent to the Bamberg Deaf and Dumb Institute as a result of cerebro-spinal meningitis, and Moos reports that in his own practice 59.3 per cent. became deaf-mutes.

In the Jacksonville Institute for Deaf-mutes I found cerebro-spinal meningitis given as the cause of deafness in 14 per cent. of the cases.

Larsen reports the following carefully examined case: "A girl aged seven years became hard of hearing on the tenth day of an attack of cerebro-spinal meningitis, totally deaf on the sixteenth day, and died on the thirty-first day. Section showed the tympanic membrane normal; fine and intense injection in the *entire middle ear*, with muco-purulent contents. In the internal auditory canal the nerves were imbedded in pus. The membranous labyrinth could not be recognized; the semicircular canals were filled with a soft reddish tissue (connective tissue with fatty degenerated round cells and blood-corpuscles); the same condition was found in the vestibule and in the cochlea; and in the vestibule of the left ear also a small quantity of pus; extensive purulent meningitis of the convexity and base; the medulla was also surrounded by purulent exudations. The microscopical examination of the acoustic, the facial, cochlear, and vestibular nerves revealed no pathological changes. The otitis was evidently caused by direct infection from the meningitis."

Micrococci.—The diplococcus of pneumonia is frequently found in middle-ear secretions, often in pure cultures, even in cases where there is no evidence of involvement of the lungs.

Since the appearance of influenza otologists have had abundant opportunity to study its influence upon the sound-conducting apparatus, and the resulting inflammations of the ears have been classified into four varieties (Moos):

1. Swelling and hyperemia of the lining of the middle ear, with little or no interference with hearing.

2. Pain, fever, diffuse redness of the tympanic membrane, and exudation into the middle ear, at first sero-mucoid, later muco-purulent.

3. "The hemorrhagic" (myringitis hæmorrhagica bullosa), the most typical of the four varieties; bullæ varying from bright red to a dull venous color are usually situated on the tympanic membrane, but at times found in the osseous portion of the canal; there are much pain, fever, and deafness.

4. The form characterized by violent purulent inflammation of all parts of the middle ear, generally involving the mastoid, with fever, pain, and great prostration.

The author has had occasion to study all of these forms, and, while the first two varieties have nothing very distinctive by which to differentiate them from similar affections due to other causes, those of the third and fourth classes are characteristic when taken in connection with the general symptoms. The hemorrhages which are so frequent in this affection, not alone in the ear, but in other parts of the body, are perhaps to be attributed to necrosis of the vessel-walls by the toxin of the influenza bacillus, which seems to have been positively identified by Pfeiffer, Kitasato, Canon, and others. This bacterium is not easy of isolation, and appears always to be found in connection with one or more pathogenic germs, or, as Ribbert states it, "the exciting germ of influenza is everywhere the quartermaster for the various pathogenic organisms."

Mumps is probably due to a bacterium which A. Ollivier claims to have isolated. In recent years quite a number of cases have been reported with severe involvement of the ears. Complete deafness of *both ears* has been reported, even where the parotitis was limited to *one side*.

Tuberculosis.—Suppuration of the middle ear is a frequent affection in the later stages of lung-tuberculosis. The ear-affection usually develops *painlessly:* the first symptom noticed is more or less marked deafness, followed by a slight discharge of a watery consistency; the disease in the severe form may, however, be accompanied by the usual symptoms of acute otitis. In case the chronic form becomes painful, we have to deal with a mixed infection of tubercle bacilli and streptococcus, with resulting increase of offensive purulent secretion, often leading to total destruction of the ossicles and necrosis of the mucous membrane, the bony walls becoming denuded, especially the promontory. There is nearly always extensive breaking down of osseous tissue, which may cause facial paralysis and even erosion of the carotid. (Seven deaths have been reported from carotid hemorrhage.)

Microscopically, we may find it a very difficult task to demonstrate the tubercular nature of the affection by examination of the secretions from the ear alone, the tubercle bacilli often being absent, while the sputum contains them in great abundance. In many cases this is due to the development of the streptococci upon the soil first occupied by the tubercle bacilli, the new arrivals flourishing, while the others become few or are not at all present in the discharge. But we must also remember that a non-tubercular suppuration of the middle ear may occur in a patient suffering from phthisis pulmonalis.

Syphilis.—Strange as it may seem, considering the prevalence of *acquired* syphilis, there are no reliable data as to the frequency of this factor being a causative agent in ear-affections. That it is one of importance is well understood; but so long as the statistics of authorities vary from 20 per cent. to less than 1 per cent., we must consider them of little value. The following changes have been observed: Condylomata of the external meatus; while inflammation of the middle ear often results from syphilitic infection of the nose and pharynx. In the internal ear we may find hyperemia, small-cell infiltration, connective-tissue formation, chalk deposits, ossifying periostitis, stapes ankylosis, and primary suppurative inflammation of the labyrinth. In inherited syphilis the disease chiefly attacks the labyrinth, developing most frequently between the ages of eight and twenty years. Hutchinson teeth and other stigmata are generally present.

Toxicants.—The abuse of certain drugs has a marked influence upon the ears, quinin, salicylic acid, and tobacco being the most important. Every one is familiar with the effect of large doses of quinin. The tinnitus and deafness have in some cases proven permanent. The subjective noises are caused by labyrinthine hyperemia in the first instance, but may later be due to ischemia. The action of salicylic acid is similar, but less marked than quinin. The direct action of tobacco upon the nerve of hearing has, so far, not been clearly established, but is perhaps similar to the action upon the optic nerve. Its deleterious effect upon the mucous membrane, causing dryness, brings about or greatly aggravates existing catarrhal troubles, involving the Eustachian tube and middle ear, causing tinnitus and the usual labyrinthine complications in advanced cases.

PATHOLOGY.

Auricle.—Transitory hyperemia of the auricle occurs not infrequently in patients suffering from chronic tympanic catarrh or from a healed purulent middle-ear inflammation associated with naso-pharyngeal catarrh, and is referable to the sympathetic nerve.

Intertrigo is an excoriation of the skin behind the ears, accompanied by secretion of serum and formation of crusts. It is often caused by keeping the ears pressed firmly against the head by infant caps, and is favored by a lack of cleanliness and a tender skin in a strumous subject.

Eczema.—The various classifications of eczema mark, after all, only different stages of the same disease, and here we need only recognize the affection as acute and chronic. Every exciting cause giving rise to hyperemia is capable of producing eczema by favoring development of bacteria. Gout, rheumatism, etc. predispose to this disease, in adults generally limited to the external meatus.

Herpes auricularis is a rare affection, distinguished by the formation of vesicles, generally located upon the anterior surface, and caused by irritation of the trophic nerves supplying the affected area.

Phlegmonous inflammation may result from infected wounds or infectious diseases, as typhoid (suppuration of the parotid), erysipelas, measles, scarlet fever, and diphtheria, and may develop primarily or by extension from the throat and middle ear.

Diphtheria may involve the aural region through the infection of open surfaces. In two patients, males, eighteen and thirty years of age, upon whom the author had performed the radical mastoid operation, there was diphtheritic infection of the wounds; in the younger, preceded by tonsillar and pharyngeal involvement; in the other the wound only was affected: both cases, however, experienced but slight constitutional disturbances. Cultures and microscopic examinations gave the typical Klebs-Löfler bacilli.

Perichondritis of the auricle is not often encountered. The cause is frequently obscure, sometimes resulting from injury or metastatic infection, as from furuncles or otitis externa diffusa. A swelling similar to othematoma develops, and a synovial-like fluid, which later becomes purulent, separates the perichondrium from the cartilage. Deformity usually results through chondromalacia. *Othematoma,* or blood-tumor of the auricle, is formed by an exudation of blood between the perichondrium and cartilage, but may occur between the perichondrium and skin. The affection is either traumatic or idiopathic, the former resulting from direct injury, causing rupture of the blood-vessels. The idiopathic variety is generally encountered in the insane, in whom the intracranial lesion, with degeneration and softening of the vessel-walls and formation of calcareous deposits, favors spontaneous rupture under increased blood-pressure during maniacal excitement or from slight self-inflicted bruises when violent. The theory of intracranial disease as a cause of the idiopathic variety has found strong support in the experiments of Brown-Séquard, who caused hemorrhage in the ears of animals in from twelve to twenty-four hours after section of the restiform bodies. The lobule is rarely affected, but may suffer. It is more frequently the seat of *abscess* from infection after piercing for ear-rings.

Keloids (*fibromata*) occur now and then as a result of wearing heavy earrings of impure metal; the growths may vary in size from a pea to a chicken's egg (Knapp), and are more common in the negro.

Atheromatous *cysts* are also found upon the auricle, generally upon the posterior surface (see Fig. 461). The serous variety also develops, although less frequently.

There are a number of affections which so rarely involve the external ear that it would be out of place to describe them at length in this article, and I shall merely name them—to wit: syphilis, lupus, hypertrophy of a part or all of the auricle, necrosis, chalk deposits, ossification, and injuries.

The External Meatus.—Hyperemia is often found in connection with inflammation of the auricle or middle ear, and may be quickly evoked by the speculum; and hemorrhage of the external meatus may result from injuries, careless removal of inspissated cerumen, or foreign bodies.

Furuncles are circumscribed glandular inflammations; hence they are most frequently situated in the cartilaginous portion of the meatus, but may also be found in the osseous canal. The central mass breaks down, forming a necrotic slough surrounded by pus; left to itself, it usually evacuates spontaneously. It is now generally accepted that the cause is in most, if not all, cases due to a bacterial infection, the staphylococcus aureus being found much more frequently than any of the other bacteria. The point of entrance is along the hair-shafts and by the mouths of the sebaceous or sweat glands. Abrasion of the skin by finger-nails, ear-curettes, hair-pins, etc. is a frequent cause of infection. Transmission by failure to disinfect the syringe-nozzle was observed in the Cincinnati Hospital in 1892. A typical case of furuncular inflammation of the external meatus was admitted, and within a short time eight cases developed among ear-patients in different parts of the house, who up to this time had not suffered from the affection. In searching for a cause I found that the same syringe had been used for all of these cases without disinfecting the nozzle; after correcting this no more cases of furuncles developed in the service.

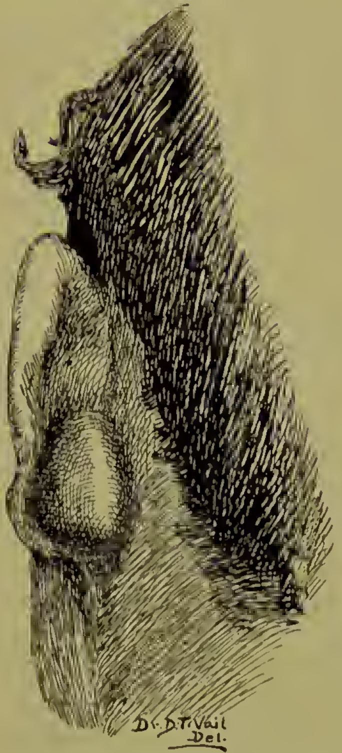

Fig. 461.—Sebaceous cyst of thirteen years' duration in a man of twenty-eight, from whose right ear a similar growth had been removed.

Reflex tropho-neurosis is also cited as a cause. The inflammation may in severe cases extend deeply, giving rise to perichondritis of the canal and auricle: even in the less severe cases we at times find extension to the tympanic membrane and middle ear. The author recently observed a case where two furuncles of the cartilaginous portion, accompanied by only slight swelling and pain, caused marked deafness, tinnitus, and the loss of a calcareous plaque in the anterior half of the tympanic membrane, with resulting perforation. When located on the posterior wall and near the orifice of the external canal, they may lead to great edematous swelling behind the auricle, even causing the latter to stand out at right angles—closely resembling, and being mistaken for, acute mastoiditis.

Otitis externa diffusa is a general inflammation of the external ear which may result from the causes given under "Furuncles." The whole lining of the canal becomes a deep red, swollen, and covered with more or less seropurulent secretion. In severe cases there is swelling and inflammation of the auricle, even extending over the mastoid and parotid, with enlargement of the glands about the ear. The middle ear is seldom involved, yet perforation of the tympanic membrane and purulent otitis media and mastoid complications may result; but the inflammation in the external meatus is not infrequently secondary to involvement of the tympanic cavity, attic, and mastoid cells.

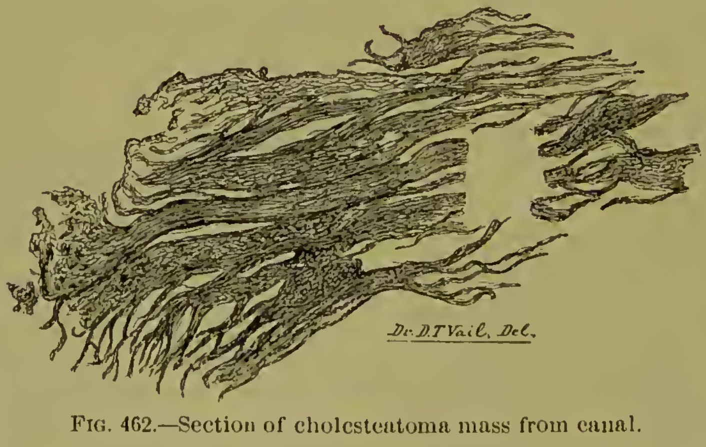

Fig. 462.—Section of cholesteatoma mass from canal.

From the latter there may be a direct opening through the posterior wall of the canal, with protrusion of granulations and discharge of pus.

Cholesteatoma (or pearl tumor) of the external canal is rare. The growth results from prolonged inflammation of the epithelium, causing excessive proliferation of the rete mucosum and exfoliation of the epidermal layer, forming laminated mother-of-pearl colored masses, in which are found numerous cholesterin crystals. Fig. 462 clearly shows the laminated structure of the growth. The ear from which this specimen was taken showed extensive changes secondary to an arrested otitis media purulenta. The external meatus was almost filled with the epithelial mass, imbedded in which were three firm globular pearl tumors from 3 to 6 mm. in diameter. Removal of these left three corresponding depressions in the floor of the meatus, equal in depth to about one-half the diameter of the round masses, and lined with a pearly membrane.

Neoplasm.—Exostoses, and hyperostoses, or bony growths of the external canal, are most frequently situated on the posterior wall, at the junction of the cartilaginous and bony canals (Figs. 463, 494). In structure they are generally of ivory hardness, but may be cancellous. They are ascribed to the irritation of discharge in some cases, and in the British upper classes, among whom they are not uncommon, to gout or inordinate bathing.

Lupus, syphilis, cysts, angioma, osteosarcoma, and epithelioma have been reported.

Otomycosis.—A number of vegetable parasites develop in the external meatus, especially the aspergillus niger, flavus, and fumigatus. Macroscopically, they appear in the deeper part of the meatus and on the tympanic membrane as brownish-black, grayish-white, or yellowish punctated masses. The germs cannot develop in the normal ear, but maceration of the epithelium from any inflammatory cause favors their growth. Examination of a fragment placed under the microscope reveals irregularly interlaced threads or hyphæ (mycelium (*a*), Fig. 464), covered more or less densely by globular masses of fallen spores (*b*); here and there a flower-like mass is found, supported upon hyphæ —*i. e.* the sporangium or fruit-capsule (*c*), consisting of the central receptaculum (*d*), upon which are seated the long radiating cells (sterigmata), (*e*); bearing the round conidia or spores.

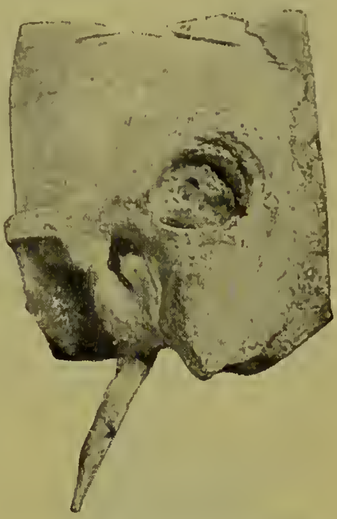

Fig. 463.—Hyperostosis of canal and trephining of mastoid (Randall).

Ceruminous masses consist of secretion from the ceruminal and fat-glands, exfoliated epithelium, hairs, and dust: their formation primarily depends upon hypersecretion, due to an excitation of the glands secondary to middle-ear congestion or inflammation. It is also claimed that subnormal secretion, comparable to the dry pharyngitis often present, is responsible for the unnatural

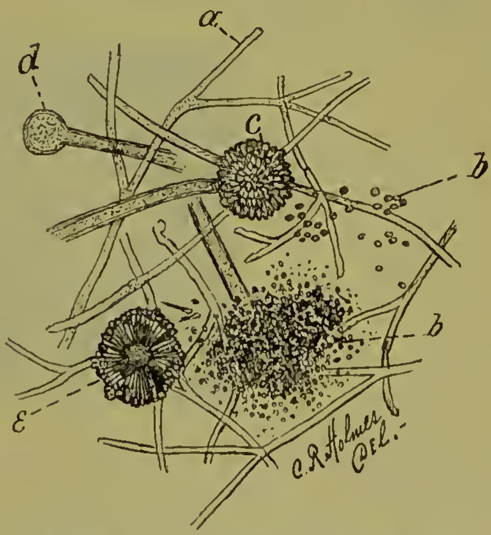

Fig. 464.—Aspergillus nigricans: *a*, mycelium fiber; *b*, spores; *c*, sporangium; *d*, receptaculum; *e*, sterigmata.

consistence and faulty exit. When large they may lead to pathological changes by pressure, erosion of the external meatus, atrophy, ulceration, and even perforation of the tympanic membrane.

The Tympanic Membrane.—Vascular engorgement, especially along the hammer-handle and Shrapnell's membrane, results readily from undue pressure of a speculum while making an examination or after syringing and forcible inflation.

Primary inflammation is rare. In mild cases the dermal or mucous layers only are affected, according as the inflammation originates from the meatus or tympanic cavity; while in the severer forms the fibrous layer is also affected with round-cell infiltration and softening, favoring perforation. Chronic inflammations lead to hypertrophic changes in the cuticular and mucous layers, with increased growth of the rete Malpighii and exfoliation of the epithelial layers. Granulations may also form. Practically, the same changes occur in the mucous layers, but here the granulations become larger, even polypoid. The changes in the membrana propria or middle layer are of an atrophic character: the infiltration and softening, aided by pressure of the pent-up exudation, soon lead to perforation, the size of which depends much upon the virulence of the bacterial infection. The seat of perforation is most frequently in the anterior lower quadrant. When the attic and mastoid cells are involved the opening is often in the upper and posterior portion. The healing of perforations is participated in only by the epidermic and mucous layers, hence the secondary membranes are always flaccid, unless, as frequently occurs, infiltration and formation of calcareous plates have resulted. When the openings are very large or repeated ruptures have taken place, the perforations become permanent, especially if the patient is past thirty.

Atrophic changes of a part or all of the drumhead are found in chronic middle-ear catarrh. The membrane is thin and drawn in sometimes in scar-like areas, strongly suggesting past perforation.

Chalky deposits are generally located in the middle portion of the anterior or posterior half of the tympanic membrane; they are most often halfmoon- or horseshoe-shaped, and rarely reach to the hammer-handle or tympanic ring. The deposits may be found only in the membrana propria, but in severe cases all layers are involved. The pathological changes found in the tympanic membrane are of themselves of little value as an index of hearing (Fig. 465), as witness the right and left drumheads of a man twenty-four years of age who suffered for many years from chronic purulent otitis media.

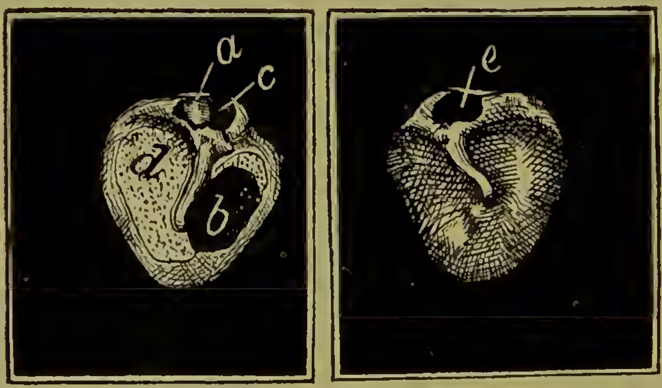

FIG. 465.—Drumheads showing perforation in the flaccid membrane (*c* and *e*): on the right, uncovering the malleus-head, and with chalk crescents (*d*) posteriorly and in the edge of the lower perforation (*b*) (Holmes).

Hearing distance, watch, right ear, whispered voice, at 20 feet, $\frac{28}{40}$;
Hearing distance, watch, left ear, $\frac{3}{40}$; only low voice spoken into the external canal.

Tympanic Cavity.—From a pathological point of view we find the most important factor in middle-ear inflammation to be its *mucous membrane.* It is in this that the inflammation must begin, and because of its *peculiarly intimate relation with its underlying periosteum* do we so frequently find that the pathological changes extend to the bone, resulting in hyperostosis or necrosis. There is great tendency to thickening of the mucous membrane, favored by the many irregularities—slit-like passages and depressions due to the chain of ossicles, ligaments, and numerous bony projections within this small space. Various classifications have been attempted; the most practical is a clinical basis, where we divide the inflammations into—

a. Sero-mucous middle-ear catarrh.
b. Proliferous inflammation of the middle ear.
c. Muco-purulent inflammation of the middle ear.
d. Acute purulent inflammation of the middle ear.
e. Chronic purulent inflammation of the middle ear.

(*a*) **Sero-mucous Middle-ear Catarrh.**—*Synonyms.*—Acute middle-ear catarrh; Secreting form of middle-ear catarrh; Otitis media serosa; Catarrh of the cavum tympani and Eustachian tube.

This form most frequently results as an extension from the nose and pharynx through the Eustachian tube. There is congestion of the mucous membrane and exudation of serum, which may be mixed with mucus, the latter resulting from the beaker-cells of the epithelium, as mucous glands are rare or entirely absent in the middle ear. A few pyogenic organisms may also be found, having entered through the tube, and may in most cases be regarded as the exciting cause. The exudation may fill a part or all of the cavity. The picture frequently presented is shown in Fig. 466. The drumhead seldom ruptures in this affection. Resorption, aided by paracentesis or spontaneously, with complete restoration of the parts, is the usual result if properly treated and the exciting cause corrected. The affection, having once developed, is liable to recurrence and may pass into the chronic form.

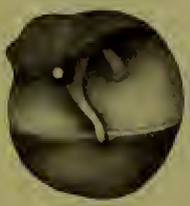
FIG. 466.—Serous fluid within the tympanum showing through the unchanged drumhead.

(*b*) **Proliferous Inflammation of the Middle Ear.**—*Synonyms.*—Otitis media catarrhalis chronica; Otitis media sclerotica; Otitis media catarrhalis sicca.

This form, as stated above, may also develop from the acute variety, but very often it begins without any active inflammatory symptoms. There is a general or circumscribed involvement of the mucous membrane, the former most often after the exudative variety; localized forms frequently involve the oval and round windows or their immediate surroundings. The mucous membrane becomes swollen by round-cell infiltration and proliferation of all its structures, which is later followed by connective-tissue formation, sclerosis, atrophy, or calcareous changes. The ossicles may be completely imbedded and the niches filled with the swollen membrane; even the space between the stapes-crura and the niche-wall may be obliterated. The opposing surfaces of the membrane press upon each other, the inflamed epithelium becomes eroded by pressure, and adhesions form which may completely fill the round-window niche. Adhesive fibrous bands may form between any or all of the ossicles and their surrounding walls. Even calcareous changes take place in the mucous membrane, generally limited to the promontory.

Ankylosis of the foot-plate of the stapes with the oval window is unfortunately a condition frequently encountered in this form of middle-ear inflammation, caused by calcification and ossification of the ligamentous ring of the foot-plate or by the formation of bony masses involving the foot-plate, niche, oval window, or in the vestibule (Politzer).

In most cases progressing toward stirrup-ankylosis there is intense hyperemia of the wall of the promontory (Schwartze); and Hartmann found in this class of cases purulent naso-pharyngeal catarrh, with intense hyperemia and swelling of the mucous membranes of these parts.

(*c*) **Muco-purulent Inflammation of the Middle Ear.**—*Synonyms.*—Acute catarrhal inflammation of the middle ear; Otitis media acuta.

The differentiation between this form and otitis media serosa is best shown in the following table:

Otitis Media Serosa.	*Otitis Media Acuta.*
Tympanic membrana remains transparent, and with only very slight or no injection.	Intense injection; inflammatory exudation, with partial or complete opacity of the tympanic membrane.
Mucous membrane of middle ear only moderately inflamed, with very slight, if any, proliferation.	Intense congestion and swelling of the mucous membrane, due to interstitial exudation and proliferation; epithelium opaque and swollen.
The exudate is a clear serous fluid or transparent mucus.	Opaque mucus, mixed with great quantities of pus-cells, or purulent fluid tinged with blood from the torn capillaries, due to the sudden swelling and great engorgement.
Absence of, or only slight, inflammatory symptoms.	Much reaction, with resulting symptoms.
Absorption, as a rule, slow.	Absorption rapid when patulency of tube is restored.

(*d*) **Acute Purulent Inflammation of the Middle Ear.**—*Synonyms.*—Acute suppuration of the middle ear; Otitis media acuta suppurativa seu perforativa.

The pathological changes are very similar to otitis media acuta, described above, but much more intense, the purulent exudation much more copious, with breaking down of the mucous membrane in circumscribed areas and early perforation of the tympanic membrane. The inflammatory changes are not limited to the lower tympanum, but the attic, antrum, and even the mastoid cells, are affected. The internal ear is generally not involved; but the free anastomosis between the vessels of the middle and inner ear may lead to great hyperemia in the labyrinth and serous effusion, seldom to purulent inflammation (Politzer). On account of the intimate relation between the mucous membrane and the periosteum we frequently see *subperiosteal abscesses and bone-necrosis.* This condition may run its course and end in resolution, with scarcely any visible changes of the tympanic membrane and middle ear, and with or without marked changes of hearing power; or the disease may continue and pass into the chronic stage.

(*e*) **Chronic Purulent Inflammation of the Middle Ear.**—*Synonyms.*—Otitis media suppurativa seu perforativa chronica; chronic otorrhea.

For convenience of study we may divide the pathological changes occurring in this disease into five headings:

1. We encounter formation of connective-tissue bands, membranes, and

masses filling the round window, partially imbedding the ossicles, and in rare cases even filling all of the tympanic cavity.

2. Cystoid spaces are nearly always found in the enormously hypertrophied mucous membranes (see *a*, Fig. 467). The formation of numerous bands and membranes within the middle ear results in the formation of spaces between them, either entirely closed off or as irregular canals which become lined with cubical or cylindrical epithelium (*b c*). These spaces are often filled with mucus and degenerated epithelial masses (*d f*).

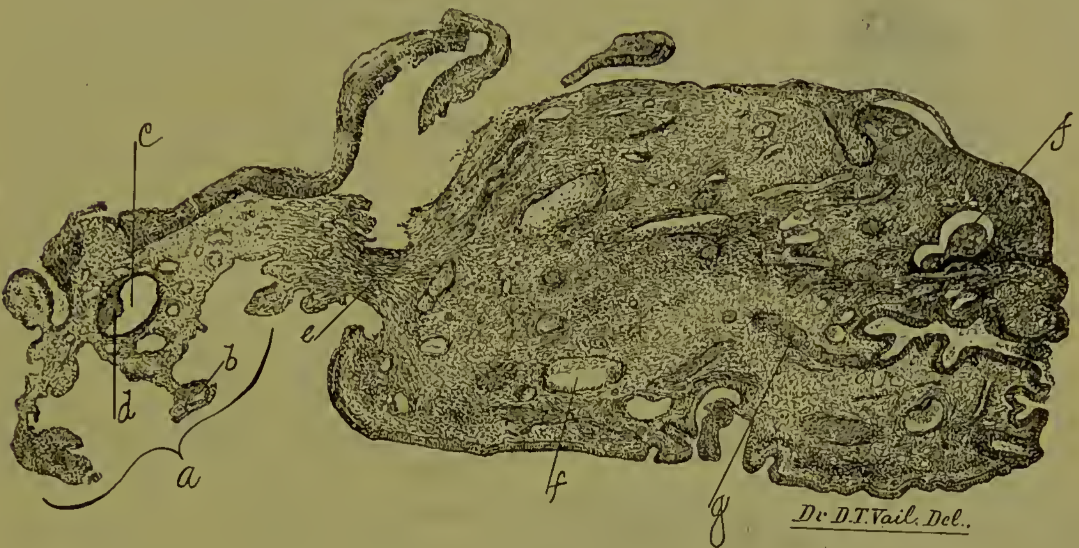

FIG. 467.—Section of aural polypus from the promontory, showing cystic spaces (*f*).

3. *Aural Polypi.*—These tumors originate from the mucous membrane or periosteum of the middle ear, or in rare instances from the dermoid layer of the tympanic membrane. Practically, we need only recognize two varieties: (*a*) The round-celled polypus (*synonyms*, Mucous polypus, Cellular polypus, Granulation tumor); and (*b*) Fibroma.

The former variety is by far the more frequent, and consists of a hyaline, homogeneous, myxomatous stroma, sustained by a delicate fibrous structure enclosing numerous round-cells. They are very vascular, the vessel-walls being of the embryonal type. The epithelial covering may occur in single or multiple layers of columnar or squamous cells, and varies according to the location from which the growth has its origin (see Fig. 467).

The fibroma, as its name indicates, contains a denser fibrous framework and is less rich in blood-vessels. Its surface is covered with several layers of pavement epithelium, which penetrate into the stroma with finger-like projections.

4. *Cholesteatoma.*—There is still no unanimity among authors as to the origin of cholesteatoma, but the best theory is that advanced by Haberman, Politzer, and Bezold, that it is due to an extension of the epithelium from the external canal or outer surface of the tympanic membrane through an opening in the latter into the tympanic cavity, attic, and mastoid cells.

In cholesteatoma of the middle ear we find the rete Malpighii in most intimate anatomical relation with the periosteal layer (see Fig. 468), the blood-vessels in the former being in direct connection with those of the latter. Continued irritation from existing otitis causes rapid proliferation of epidermic cells, resulting in the "throwing off" of pearl-colored layers from the stratum corneum, which explains the laminated structure of the cholesteatomatous mass.

Complete epidermization of the middle ear (including the mastoid cells) can, according to Schwartze and Politzer, occur without leading to the formation of cholesteatoma if the inflammatory process is arrested early. This is also proven in those cases where the radical mastoid operation has been performed on patients suffering from extensive cholesteatoma-formation in the middle ear. Here we aim to "paper" the whole of the bony cavity with an epithelial lining, taking its origin from the transplanted flaps formed from the external meatus: notwithstanding these conditions we are now enabled to cure most of this class of cases. I have operated upon several cases from three to five years ago, which can now be classified as cured, since there is no sign of any return up to date.

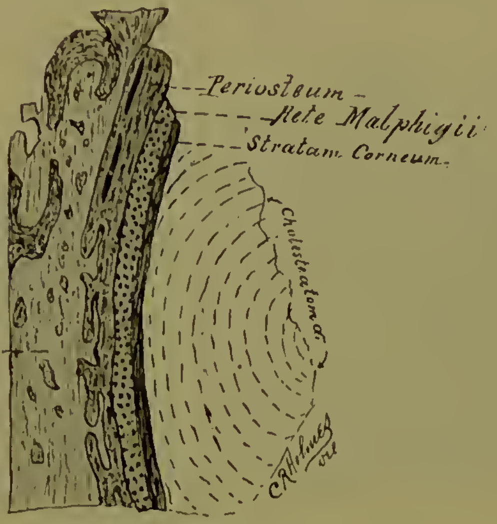

FIG. 468.—Section through osseous wall of antrum, showing periosteum, rete Malpighii, and stratum corneum (and cholesteatoma, diagramatic) (after Kuhn—Z. f. O. xxi.).

The epithelial invasion may also take place through a fistulous opening of the mastoid cortex or posterior bony meatus (Politzer).

The size of the cholesteatomata may vary from a pinhead to a pigeon's egg. When large they cause absorption of the bony walls in any direction. In two of my cases the cortical plate of the mastoid had been entirely absorbed, so that when making the incision the knife cut directly through the skin and into the cholesteatomatous mass.

5. *Bone-involvement.*—Because of the intimate relation of the mucous membrane of the middle ear and its periosteum we frequently encounter superficial or deep bone-involvement in purulent inflammations. The hammer and anvil (rarely the stirrup) are often eroded or even totally destroyed (Fig. 469).

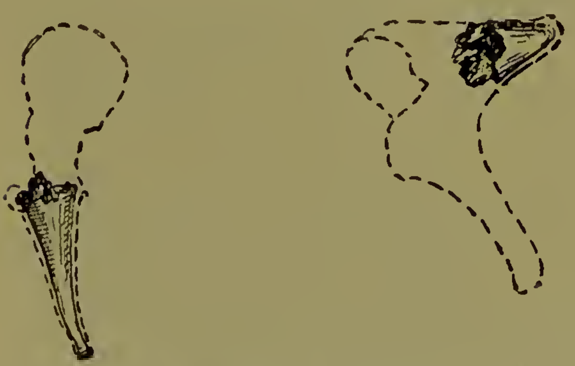

FIG. 469.—Remains of ossicles from a boy of twelve. Dotted lines indicate loss of bone by caries.

Suppurative Middle-ear Inflammation with Tuberculosis.—Middle ear suppuration is frequently associated with lung-tuberculosis, and is characterized by the formation of one large or several small perforations in the tympanic membrane, with extensive tissue-changes, *without the usual pain* and inflammatory symptoms. But we must bear in mind that we may find non-tubercular purulent otitis media in a patient suffering from tuberculosis in other parts of the body. Neither must we conclude that the aural affection is non-tubercular when we fail to find the tubercle bacilli in the secretion: their presence or absence in the ear may depend upon the period of the infection and upon the number and activity of the streptococci (Moos). The mucous membrane first becomes infiltrated by cellular proliferation, followed by ulceration, tubercle formation, and caseous degeneration. This may extend deeper, involving the bone, which becomes denuded or carious; the ossicles are also generally involved, even the foot-plate of the stirrup may be eroded and the disease extend to the internal ear and cranial cavity.

Eustachian Tube.—The mucous membrane of the Eustachian tube is subject to the same changes that we find in the naso-pharynx, and disease may extend to the middle ear by continuity of tissue or by the entrance of infected secretion through its lumen during violent acts of coughing and sneezing, by Valsalva's method, or by the use of unclean catheters and bougies.

To guard against infection the movement of the ciliated epithelium is directed *from* the tympanic cavity *toward* the pharynx; while the isthmus, or narrowest portion of the tube at the junction of the bony and cartilaginous portions, forms another barrier. If the disease has once passed beyond these, and especially the chronic catarrh, then we cannot hope for a cure in the middle ear until the inflammation of the nose and pharynx has been relieved (see pp. 727 and 747).

Where the inflammation becomes chronic, there is thickening of the mucous membrane, with increased prominence of the normally existing folds in the tube, which, with increased secretion from the glands, causes occlusion of the lumen, preventing free ventilation of the middle ear. This condition may continue for years, but sooner or later the atrophic changes begin, with partial destruction of the glands, and reduction or obliteration of the folds; the mucous membrane becomes thin and the tube patulous. Occlusion of the tube is observed as a result of ulceration from syphilis, diphtheria, and tuberculosis.

The Mastoid.—The intimate communication between the tympanic cavity and mastoid cells, and direct continuation of the mucous membrane from one to the other, explain why in severe inflammation pathological changes are found both in the antrum and adjoining cavities. There is great tendency to periosteal involvement and necrosis of the bone (see Fig. 504), with formation of abscesses—subperiosteal or extradural as well as truly empyemic: especially is this likely to occur if through swelling of the mucous membrane the passage is closed between the antrum and the rest of the tympanic cavity.

Where the inflammation is chronic we may have hyperplasia of the osseous tissue, which gradually obliterates all of the pneumatic spaces, resulting in sclerosis or even in eburnation of the bone. At the same time, periosteal irritation may lead to hyperostosis of the exterior of the mastoid (see p. 751).

Labyrinth.—In general anemia we observe disturbance of the internal ear. The symptoms are at times especially marked where there has been great and sudden loss of blood. Diminution of the caliber of the labyrinthine vessels, due to endarteritis, is also a factor. Hyperemia may result from a number of causes, such as general congestion, inflammation of the middle ear, meningitis, and the various infectious diseases.

Hemorrhage into the labyrinth may result from injury, infectious disease, meningitis, pernicious anemia, and abuse of various drugs. The hemorrhages may be small and quickly absorbed, with restoration of function, or more extensive, with partial or total loss of hearing. The apoplectic forms of Ménière's disease are regarded as due to hemorrhage or acute exudation.

Secondary inflammation of the internal ear is frequent and may result from—

a. Inflammation of the middle ear, the avenue of infection being generally through the windows, external semicircular canal, lymph- and blood-vessels.

b. Meningitis, often resulting in total deafness and, if in early childhood, deaf-mutism. In this disease we often find thrombosis of the smaller vessels and erosion of their walls, due to bacterial toxin, while the acoustic nerve is often infiltrated with small hemorrhages and bacterial colonies. If the patient survives the meningeal attack, the inflammation in the labyrinth may run a chronic course, granulation-tissue forms, which again changes to connective tissue associated with development of new bone, partially obliterating the spaces within the labyrinth (see Fig. 514, p. 768).

Acquired Syphilis.—Considering the frequency of this disease, we must regard labyrinth complication as rare, and in cases where it does occur we nearly always find that the patient has previously suffered from catarrhal or purulent otitis, which caused congestion of the internal ear, acting as a predisposing factor.

The syphilitic inflammation of the labyrinth may develop in one or both ears at almost any period after the infection, but most frequently during the first two years. The chief pathological changes found consist of endarteritis, with partial or total obliteration of the vessel lumen. The inflammation may lead to necrosis or the formation of new osseous deposits, causing synostosis of the stapedio-vestibular articulation: strangulation of the auditory nerve by periostitis and bony deposits in the internal auditory canal are also encountered.

Hereditary syphilis generally attacks the internal ear between the eighth and twentieth years, and is found from three to five times more frequently in the female than in the male. It is generally associated with interstitial keratitis, but the latter often exists without affection of the labyrinth. Hutchinson found deafness only 15 times in 102 patients suffering from syphilitic keratitis. The pathological changes found in the internal ear as a result of inherited syphilis are very similar to those resulting from the acquired infection.

Internal Auditory Canal.—Inflammation of the acoustic nerve is encountered as a result of extension from the labyrinth to the brain, or the process may be reversed. In 14 cases of mixed forms of meningitis examined by Gradenigo he found that the inflammation involved the nerve in the internal meatus 13 times, the one exception being in a case where the meningitis had existed only a few hours.

EXAMINATION OF PATIENTS; SYMPTOMATOLOGY AND DIAGNOSIS; INSTRUMENTS NEEDED, AND METHODS OF THEIR EMPLOYMENT.

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THE clinician must always bear in mind the embryological and physiological division of the organ of hearing into a sound-conducting and a sound-perceiving apparatus, as contrasted with the anatomical division into three parts, the external, middle, and internal ear—the sound-conducting apparatus consisting of the external and middle ear; the sound-perceiving apparatus including, of course, the internal ear, the auditory nerve, and the perceptive centers in the brain. While a consideration of the function requires only the division into conducting and perceptive portions, the threefold anatomical division is, on the other hand, necessary for examination: since for the external ear, including the periotic region, the auricle, external auditory canal, and membrana tympani, we depend principally on inspection and palpation; for the middle ear, including the Eustachian tube and tympanic cavity, we must rely largely on pneumatic measures; and for the internal ear on acoustic methods.

The general plan which it is proposed to follow in this chapter is to describe the methods, in the order in which they come, which I have for years followed as a routine in my daily examination of patients. These may be divided according to the following general arrangement:

I. Clinical History, with General Symptomatology;
II. Functional Examination;
III. The Periotic Region;
IV. Otoscopy;
V. Examination of Nose, Naso-pharynx, and Pharynx;
VI. Examination of the Middle Ear.

By a general adherence to this plan it is believed that accuracy of diagnosis, the *sine quâ non* of proper treatment, may be most uniformly attained. As an incentive to uniformly thorough examination in every case the writer is a firm believer in some form of history blank, which each aurist may develop by experience to suit his own needs. The one shown at the end of this chapter is the result of the combined experience of my colleague, Dr. Alderton, and myself, and is the one which we have used for several years with eminent satisfaction. The blanks are printed on moderately stiff cardboard, so that they may be kept for reference after the manner of a card catalogue.

I. THE CLINICAL HISTORY, WITH SYMPTOMATOLOGY.

A record should first be made of the patient's name, address, age, date of the first visit, occupation, whether previously treated, and, if so, to what extent; after which the patient's general condition of health should be inquired into. The patient should then be asked to state what is the most *troublesome symptom, the principal cause of complaint,* this statement to be followed by a careful inquiry into the *duration* of the trouble. My reason for thus commencing the investigation is that in routine cases much time will be saved through thus early getting information which will result in the following questions being asked more intelligently. The so-called *cardinal symptoms,* of one or more of which the patient will complain, and as to the general significance of which a few words are demanded, are the following: (*a*) Defect of hearing, (*b*) tinnitus, (*c*) pain in or around the ear, (*d*) discharge from the ear, (*e*) visible alterations in the external parts, (*f*) vertigo. It should be remembered that most of these symptoms may arise from extra-aural causes; defect of hearing may be due to intracranial lesions; pain is frequently felt in the ear when the trouble is at a distance; tinnitus may be due to increased arterial tension, anemia, toxic, or other general causes; and vertigo has a varied origin. On the other hand, serious constitutional disturbance may arise from unobserved ear-disease—*e. g.* some obscure pyemias.

Defect of Hearing.—The quantitative and qualitative determination of this will be described later. As having a certain symptomatic value may be mentioned the following generalizations: An insidious onset, without definite cause and with early occurrence of tinnitus, is suggestive of middle-ear catarrh (sclerotic form). Relatively rapid loss of hearing (from good hearing to great deafness within a month), with but few or no accompanying symptoms, suggests the possibility of labyrinthine syphilis. Sudden deafness without symptoms points to the probability of cerumen impaction. "Hearing better in a noise" (paracusis Willissii) means, as a rule, a special form of middle-ear disease; while those with nerve-deafness—boilermakers and others—usually hear worse in a noise. Autophonia or tympanophonia, that condition in which the patient's voice seems to him to go out through the ear instead of the mouth, indicates, as a rule, some pathological condition of the Eustachian tube, but is occasionally present in other conditions of the middle ear or in impacted cerumen. It is, on the contrary, so far as my knowledge goes, never met with in internal-ear troubles.

Tinnitus should next be inquired about. It is variously described by patients, but two general classes may be made out: 1. Pulsating, due to arterial congestion which is probably in either the external or middle ear if it is stopped by pressure on the common carotid, and in the internal ear if stopped by pressure over the vertebral artery in the suboccipital triangle; 2. Non-pulsating, or continuous, with varying characteristics: the high-pitched sounds, hissing, singing, etc. are often due to increased tension in the middle ear, irritating the auditory nerve, and often relieved by inflating the tympanum; the deep humming sounds, worse after exertion, relieved after lying down a little time, are often due to anemia; the rushing sounds are often due to venous congestion, are worse on lying down, and may be relieved by purgation. Finally, it should not be forgotten that the hearing by the insane of bells, music, voices, etc. may be caused by aural disease, at times remediable. It is of course easy to locate in the middle ear the little cracking due to swallowing, the crackling caused by air entering a tympanic cavity containing fluid, the loud pulsating sounds accompanying acute inflammations of the membrane, the tympanum, or the mastoid cells, or the loud, at times rhythmic, noises due to contraction of the palatal muscles, generally with participation of the tensor tympani or stapedius muscles (often perceptible to others).

Pain—earache—is an important symptom, and should be carefully investigated. It accompanies acute inflammatory affections of the external and middle ear, the exacerbations common in chronic middle-ear inflammations, with extension of caries or development of cholesteatoma, as well as mastoiditis and mastoid periostitis. In inflammation of the external ear the pain is usually accompanied by tenderness in front of or below the auricle, and is increased by motion of the jaw. If it is the tympanic membrane or tympanum that is involved, the pain is accompanied by more or less deafness, and is increased by sneezing, coughing, blowing the nose, or by inflation. Pain in the course of a chronic middle-ear suppuration usually indicates pus-retention, and is described by the patient as deep-seated. In inflammation of the mastoid or its covering periosteum the pain is more or less radiating in character, and is commonly attended by tenderness over all or part of that process. Reflex pain, neuralgic in character, is often felt in the ear, all the other cardinal symptoms of ear-disease being absent, and is caused by diseased teeth, inflammatory conditions about the throat and tongue, and by malarial poison and the rheumatic diathesis.

Discharge.—Inquiry should be made whether there is discharge, and, if not, whether it has previously existed. If there has been discharge which has ceased, then it is only natural to expect to find the results of such suppuration in the shape of cicatrices in the membrane, old dry perforations, or more or less binding down of the structures in the tympanic cavity by cicatricial tissue; if there is discharge, note the quantity, the time since it commenced, the nature of it—that most frequently found is pus—and if this be in considerable amount, and particularly if it contain mucus, it is safe to say the trouble is in the middle ear and that the membrane is perforated; when mixed with blood it usually indicates granulations or polypi; a copious hemorrhage late in a chronic suppurative case usually means erosion of a blood-vessel, internal carotid or bulb of the jugular. A scanty discharge, at first watery, then purulent, attended with itching, would indicate the external canal as the source. Fetor of the discharge is of relatively little diagnostic value unless very persistent under treatment, when it becomes suggestive of diseased bone or retention of putrefactive material in the antrum or mastoid cells. Duration of discharge and mode of onset are significant. A recent sudden discharge, preceded by pain, indicates acute middle-ear inflammation; but if *not* preceded by pain in an ear which has not previously discharged, suspicion of tubercular trouble should be at once aroused. A history of discharge recurring at intervals of from two weeks to two months, lasting but a short time, and usually preceded by pain, is good ground for suspecting attic trouble with perforation in Shrapnell's membrane. The long standing of a suppuration indicates most often neglect; in other cases granulations, polypi, carious ossicles, involvement of the antrum or mastoid cells, and at times naso-pharyngeal disease or constitutional dyscrasia.

Vertigo.—Under this heading may be mentioned not only the disturbances of equilibrium, but, as being closely allied thereto, the nausea, vomiting, and loss of consciousness which at times accompany conditions and manipulations of the ear. Since we see these symptoms with pathological conditions of the several parts of the ear, they cannot be said to indicate any particular disease, excepting possibly in the case of a patient having a tendency to fall always in the same direction. As a rule, the patient falls away from the affected ear, and in such a case it is presumptive evidence in favor of a lesion of the internal ear, probably some portion of the semicircular canals. An attack which from the suddenness and severity of its first appearance seems almost apoplectiform in character, attended by deafness, tinnitus, and often vomiting, suggests, of course, hemorrhage into some portion of the labyrinth. Less violent vertigo arises from increased tension of the labyrinthine fluid secondary to middle-ear disease—*e. g.* pressure of a granulation or a cholesteatomatous mass upon the stapes, or from syringing too forcibly or with too cold water. There are various other sources of vertigo, however, besides the ear, which must be excluded.

Cause.—Having thus gone through with the symptomatology, the patient should next be interrogated as to the *supposed cause*—whether there may have been an injury to the ear or head; in regard to bathing, to head-colds, throat-affections, mouth-breathing, exanthemata, or whether he has had syphilis, rheumatism, or gout; or if he has been taking large doses of medicine, such as quinia or the salicylates; and finally, whether or not the occupation may have any bearing on the case. Under this heading information of great value will be frequently obtained as regards both diagnosis, prognosis, and treatment. As the next step, may be summed up, as briefly as possible, the *course* of the trouble, a recapitulation, as it were, of the history as gained up to this time—the principal complaint, its mode of onset, its duration, and the necessary data with regard to the symptoms. The final step in this part of the examination, which in very many cases may be omitted, is an inquiry into the family history with regard to deafness. Since in some cases important information is obtained, it seems well to have a space in the history blank devoted to *heredity*. Following this is another space for "Remarks," which should be a part of every record blank, in which should be noted anything of interest peculiar to the case and for which there is no place elsewhere.

II. FUNCTIONAL EXAMINATION.

Having thus finished the preliminary examination, the next thing to investigate is the function of the organ. How much is the hearing impaired? Where is the lesion that causes the deafness?

1. Quantitative Tests.—To determine *how much* the hearing is affected compare the distance the ear under examination hears a given sound with the distance the same sound is heard by a normal ear. This is conveniently expressed in fraction form, as suggested by Prout, the denominator representing the hearing distance, in feet or inches, of the normal ear; the numerator, that of the ear being investigated. The sounds most used as tests are the tick of a watch and of Politzer's acoumeter, the voice, and the vibrations of the tuning-fork. The watch-tick answers very well for observations by the same individual, but does not permit a comparison of results with those of other observers. To meet this objection Politzer devised his *acoumeter* (Fig. 470), so that all might have an instrument giving a sound of uniform quality and intensity. In testing the hearing with either of these they should be gradually brought from beyond the limit of hearing *toward* the ear until heard. The ideal test for impaired hearing, however, is the human voice, and the different degrees of deafness are represented as hearing for whispered words, for ordinary, loud, or shouting

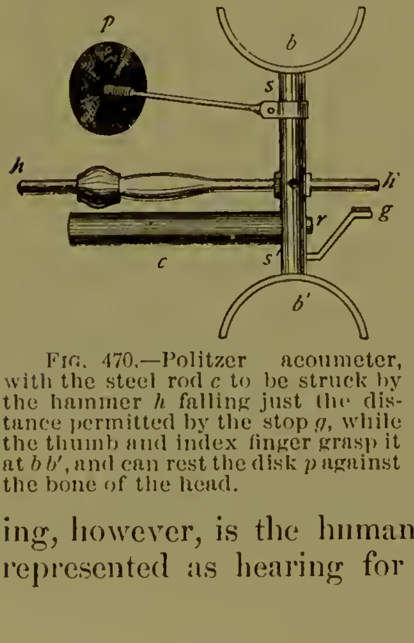

FIG. 470.—Politzer acoumeter, with the steel rod *c* to be struck by the hammer *h* falling just the distance permitted by the stop *g*, while the thumb and index finger grasp it at *b b'*, and can rest the disk *p* against the bone of the head.

conversation. For different observers to obtain as nearly as possible a uniform result in the test with whispered words the so-called "reserve-air" method should be used, the reserve air consisting of what is left in the lungs after a forced inspiration followed immediately by a normal expiration. Since patients become rapidly accustomed to test-phrases if repeated, this should be avoided—*e. g.* by using numbers, of two figures, interspersed at times with words or phrases of another character. To avoid error if one ear is very deaf and the other but slightly so or not at all, with the latter stopped tightly with the moistened finger of the patient, or, better still, of an assistant, and the deaf ear toward the examiner, note the result; then have in addition the deaf ear tightly stopped and repeat the tests. If, now, the patient hears the same as with the deaf ear unstopped, it is evident that deafness is complete, and that the hearing in the first test was with the stopped ear. Since the mere sound may be heard, the patient should be made to repeat the words in all the tests.

2. Qualitative Tests.—Having with the preceding tests found the amount of deafness, the purpose of the following measures is to locate the lesion either in the sound-conducting or the sound-perceiving apparatus, for which purpose we use the Galton whistle and tuning-forks of various pitch. The normal ear perceives vibrations as musical notes when repeated at regular intervals from 16 up to 32,500 vibrations to the second, and these may be called the lower and upper limits of audition. These limits vary in a characteristic way with disease of the conducting or perceiving apparatus. Again, there is a fairly definite ratio in the normal ear between the duration and loudness of tuning-fork vibrations by air- and by bone-conduction, and this ratio is altered more or less definitely according to the part of the ear affected by disease. The lower tone-limit, or rather any lack of hearing for the lower notes, may be determined with sufficient accuracy by means of the C′ large-clamp tuning-fork (Fig. 471), whose range of vibrations is from 26 to 64 to the second. The upper tone-limit can be most accurately determined by König's rods, but these are too time-consuming for daily use, and Galton's whistle (Fig. 472) gives the same result much more quickly and with sufficient accuracy.

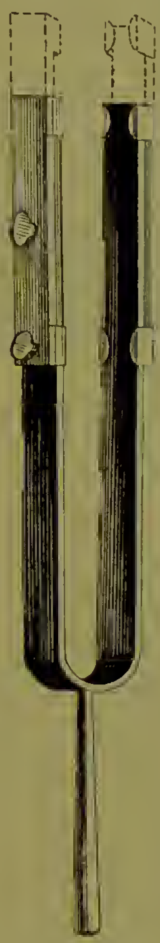

FIG. 471.—Dench's large tuning-fork with clamps at ends, giving 64 v. s., and without clamps 26 v. s.

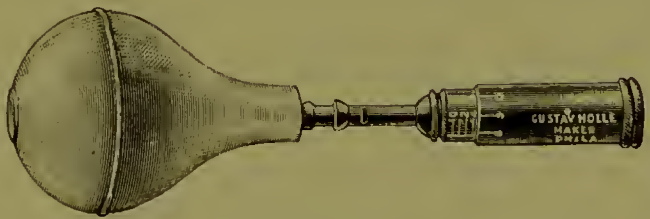

FIG. 472.—Galton's whistle with rubber bulb. The pipe below the opening is filled by a plunger advanced or withdrawn by a screw, each turn being shown by the scale upon the enlarged tube, and its tenths by that on the revolving collar. It gives an audible sound from 0.5 (theoretically, 84,000 v. s.) to 10 or 12 (4200 or 3500).

To properly compare air- with bone-conduction we need the absolute duration of each and the relative intensity of the two. To obtain the former a freshly struck tuning-fork is held in front of the external auditory canal, the time in seconds being taken from the moment it is struck until it ceases to be heard by the patient; duration of bone-conduction is obtained in the same way, except that the handle of the vibrating fork is rested firmly upon the mastoid process until it is no longer heard. Relative intensity is obtained by placing a freshly struck tuning-fork in rapid succession two or three times upon the mastoid and opposite the meatus, and having the patient determine whether air- or bone-conduction is louder. By air-conduction the sound-waves reach the perceptive centers through the sound-conducting apparatus; by bone-conduction the path is through the cranial bones. In the normal ear the duration of air-conduction is, roughly speaking, about double that of bone-conduction. In obstructive trouble in the conducting apparatus the duration of air-conduction is lessened as compared with that of bone-conduction. In trouble with the perceptive apparatus the duration of both is lessened, that for bone- relatively more than that for air-conduction, especially for the higher forks. Aided by these facts, the methods of locating the lesion may be briefly reviewed.

Weber's Test.—Weber found that if a vibrating tuning-fork was placed upon the middle line, antero-posteriorly, of the head, either on the vertex, forehead, or upper incisor teeth, and one ear stopped, the fork was heard louder in that ear. Reasoning from this, in any given case, if the hearing is impaired in one ear only or unequally in the two ears, and a vibrating fork on the vertex is heard *better* in the worse-hearing ear, it follows that the lesion in the bad ear is an obstructive one—*i. e.* in the sound-conducting apparatus; and, *vice versâ*, if it is heard *worse* in the worse-hearing ear, then the trouble is in the perceptive apparatus.

Rinné's Test.—If the conducting apparatus in any given case is normal and a vibrating fork is pressed upon the mastoid until it ceases to be heard by bone-conduction, and is then held opposite the meatus, it is again heard by air-conduction. If the conducting apparatus is affected to any marked extent, the vibrating fork, allowed to die away on the mastoid, is not heard when brought opposite the meatus. In the former case (air-conduction exceeds bone-conduction, A.-C. > B.-C., and Rinné's test is said to be positive (R. +), and indicates, as a rule, no marked trouble with the conducting apparatus (middle ear). In the latter case bone-conduction preponderates (B.-C > A-C.), and Rinné's test is negative (R. —), indicating disease of the conducting parts (middle ear).[1] In many cases, undoubtedly, Weber's and Rinné's tests give valuable information; yet there are many, the doubtful or border line, cases in which they cannot be relied on for diagnosis.

Schwabach's Test.—In this method the Hartmann series of five forks is used: $C = 128$ v. s., $C^{I} = 256$ v. s., $C^{II} = 512$ v. s., $C^{III} = 1024$ v. s., $C^{IV} = 2048$ v. s.; and of these the absolute duration and the relative intensity of both air- and bone-conduction are noted. When compared with the results obtained from examination of a series of normal ears this furnishes data which, in my judgment, are most valuable for diagnostic purposes. The C^{-1} fork, 26 to 64 v. s., may be added to the series. As Alderton has shown, for routine work a sufficiently accurate result in the majority of cases may be obtained by using the low fork C^{-1} or C and the C^{III} fork, these indicating

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[1] The terms "R. +" and "R. —" in themselves mean nothing; in fact, I have reason to believe that experienced aurists have not infrequently to stop and mentally translate them. As substitutes, for general adoption, I propose the following formulæ, which I know are, in practice, largely used: viz. for Rinné +, A.-C. > B.-C. (air-conduction greater than bone-conduction), and for Rinné –, B.-C. > A.-C. (bone-conduction greater than air-conduction). These formulæ convey a definite idea, and their use is not attended with any more consumption of time or space.

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pretty clearly the location of the trouble. A diagnosis of middle-ear trouble, having eliminated by inspection obstructive trouble in the external auditory meatus, may be made after going through with some or all of the above tests —I. If there is loss or impairment of hearing for the lower notes of the scale, with elevation of the lower tone-limit; II. If air-conduction only is diminished, bone-conduction remaining unchanged or even increased—the normal ratio of B.-C. $<$ A.-C. being thus changed, particularly so for the lower notes. If the lesion is marked, B.-C. becomes louder and longer than A.-C.; III. If with the impaired hearing the upper tone-limit by A.-C. is but little, or not at all, affected. Diseases of the internal ear are recognized in the same manner by—I. No elevation of the lower tone limit; II. The maintenance through the lower notes of the normal ratio between A.-C. and B.-C., the absolute duration of both being, however, reduced, and very markedly so, that for the higher notes by B.-C.; III. Lowering of the upper tone-limit, with frequently entire deafness for certain of the higher notes.

To illustrate the manner of recording in compact form the result of tuning-fork investigations, I have subjoined a record for normal hearing, for chronic middle-ear catarrh, and for disease of the sound-perceiving apparatus. The relative intensity is shown in the horizontal space marked Rinné—A.-C. being louder than B.-C., it will be observed, throughout the series in normal hearing and in nerve-deafness; the reverse being true for chronic catarrh, B.-C. being louder than A.-C., except for the highest fork, in which the intensity by A.-C. and by B.-C. are about equal. The figures represent absolute duration in seconds, the upper line representing the duration by A.-C., the lower one that by B.-C.:

1.	A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	Rinné.
A.-C.	25	15	33	32	22	Schwabach.
B.-C.	13	7	13	13	14	
	C	C^{I}	C^{II}	C^{III}	C^{IV}	

1. Typical of normal hearing.

2.	B.-C.	B.-C.	B.-C.	B.-C.	Equal
A.-C.	6	6	10	11	12
B.-C.	15	11	16	13	9
	C	C^{I}	C^{II}	C^{III}	C^{IV}

2. Typical of obstructive trouble in the sound-conducting apparatus.

3.	A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	Rinné.
A.-C.	17	15	19	11	10	Schwabach.
B.-C.	8	7	3	3	1½	
	C	C^{I}	C^{II}	C^{III}	C^{IV}	

3. Typical of trouble in the sound-perceiving apparatus.

To those who wish to get along with the smallest possible number of diagnostic instruments for ear-work it may be said that fairly accurate opinions may be formed with the use of but three instruments—viz. a low-pitched tuning-fork (C^{-1}), 26 to 64 v. s., to determine the lower tone-limit, and thereby the presence of trouble in the conducting apparatus; a Galton whistle, to determine the upper tone-limit, and thereby the presence of disease of the perceptive apparatus; finally, another tuning-fork, of 512 or 1024 v. s. (with such a group of instruments, I should say the one of

1024 v. s. would give the most information), for the determination of absolute duration of A.-C. and B.-C. To one determined to get along with but one fork I would recommend C^{II} of 512 v. s., but with this alone accurate diagnostic work is impossible. Other tests have been devised to aid in locating diseases of the ear.

Gelle's Test (*Pressions Centripetals*).—In the normal ear, if a vibrating tuning-fork be placed on the vertex, and then the air in the external auditory canal be compressed, the sound dies away, to return again with removal of the compression. This is believed to prove mobility of the chain of ossicles, but particularly of the foot-plate of the stapes in its niche, and Gelle's test is positive, + ; otherwise it is negative, — ; *i. e.* in rigidity of the ossicular chain (trouble in the conducting apparatus).

Bing's test or *experiment* is essentially a modification of Weber's test. A vibrating tuning-fork is held on the vertex until it ceases to be heard; then either external auditory canal is closed with the finger, and the fork is again heard for an interval which is called the period of secondary perception. With a normal conducting apparatus this interval of secondary perception is well marked; hence if the interval is shortened a lesion of the sound-conducting apparatus is to be inferred. If the interval be normal and yet deafness is present, the seat of the trouble must be in the perceptive apparatus.

Other tests, a detailed description of which is forbidden by lack of space, are those of Itelberg and Gradenigo relative to the "fatigability" of the perceptive apparatus; that of "binaural synergy" of Gelle; the "interference otoscope" of Lucae; and the reaction of the auditory nerve to the electric current.

III. THE PERIOTIC REGION.

Having thus finished the preliminary history and the functional examination, we may now investigate the parts surrounding the auricle, making use of inspection and palpation for this purpose. The *supra-auricular* region is at times the seat of subperiosteal abscesses in adults as well as in children. The *preauricular* region may be the seat of mumps, lymphadenitis, parotitis, or pus-burrowing. In the *infra-auricular* region lymphatic inflammation with redness and swelling is common in acute inflammatory affections of the external ear. A hard, cord-like, tender swelling along the anterior border of the sterno-mastoid muscle should arouse suspicion of sinus-disease involving the jugular. A more diffuse, hard swelling in this region is a common accompaniment of the Bezold form of mastoid abscess, breaking into the digastric fossa. The *postauricular* or *mastoid* region should always receive careful attention, particularly in cases attended by pain or suppuration. There may be pain, tenderness, redness, swelling, fluctuation, sinuses, or cicatrices. *Pain,* with or without other evidence of underlying trouble, is one of the most important symptoms of mastoid inflammation. The *point of greatest tenderness,* whether *on* or *behind* the mastoid process, should be noted, remembering that tenderness of the mastoid itself usually means underlying inflammation, while tenderness behind it, particularly if at the seat of the mastoid foramen, may mean disease of the lateral sinus. *Swelling* is either circumscribed and movable, when it indicates an inflamed gland, or diffused, as in subperiosteal abscess, etc. *Fistulæ* and *sinuses* must be carefully investigated. When congenital they usually open anteriorly, and are often attended by other malformations. When acquired they are most often postauricular, and may lead to the remains of a superficial (glandular) abscess, forward to the external auditory canal, to the periosteum, to the underlying bone, to the interior of the petrous bone, to the groove for the lateral sinus, or into the cranial cavity. The presence of *cicatrices* may throw light on the nature of previous troubles.

IV. OTOSCOPY.

Now that we approach the examination of the ear itself, it should be remembered of the external auditory canal that it is somewhat oval in section, about 1¼ inches in length, its general direction inward, forward, and upward, and that it is somewhat angled at the junction of the cartilaginous with the bony portion. Hence to straighten the canal for purposes of examination the auricle must be pulled outward, backward, and upward, except in infants and young children, in whom, owing to the absence or shortness of the bony portion, it should be pulled downward instead of upward (see Plate 10). The relation of the tympanic membrane to the inner end of the canal should also be borne in mind, the plane of the membrane being from above and behind in a direction downward, forward, and inward, in the very young approaching more nearly the horizontal than in the adult (? Ed.), so that the posterior superior quadrant is nearest to the outer end of the canal, and may easily be injured, particularly in children, by the careless introduction of a small speculum.

Illumination.—To examine an ear it is necessary to have some means of illuminating it, and, since direct illumination is for various reasons unsatisfactory, we now use altogether the reflecting mirror, preferably so fixed with a band as to be used as a head-mirror, which may, if desired, be used as a hand-mirror. It should be provided with a double ball-and-socket joint (Fig. 473); may vary in size from 2″ to 4″ in diameter; should have a hole in the center, through which the examiner may view the ear; should be concave, and, most important of all in making a selection, should have a focal length of not less than 6 nor more than 10 inches.

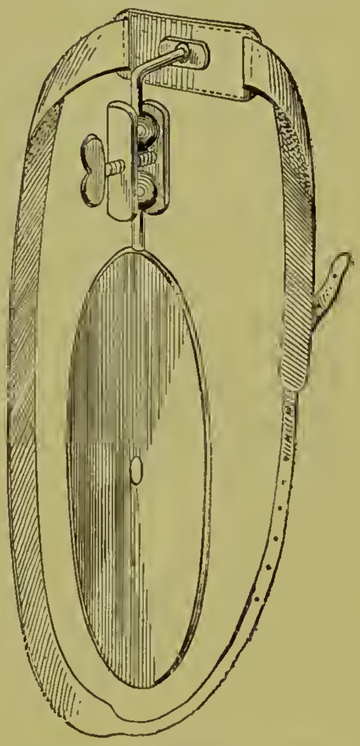

Fig. 473.—Forehead mirror.

Of next importance to the mirror is the speculum. This may be made of metal (German silver, aluminum), hard rubber, glass, or celluloid; it may be round or oval in section, with or without a curve between the large and small ends, may be long or short, and made up in sets or "nests" of three or four different sizes. The choice of material may depend largely upon personal preference. Each kind has its advantages and disadvantages. My own preference is for the hard rubber, or, still more, for the pinkish (flesh-colored) celluloid, which I have now used for two years with great satisfaction.

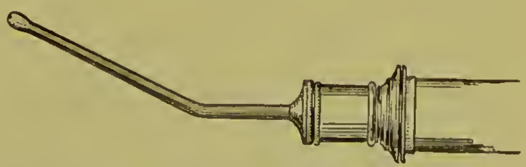

Fig. 474.—Angled syringe-tip.

Other instruments needed for the routine examination of the ear are such as are used for the removal of the frequently-found obstructions in the canal—cerumen, hairs, epithelial flakes, cotton, etc. These, when small or in the cartilaginous portion may often be pushed aside by the speculum, but, if large or in the bony canal, must be removed by other means. Should the canal be blocked by a large ceruminous or epithelial plug, a foreign body, or with pus, it is best cleansed by the use of a syringe and warm water. The most satisfactory form of syringe for office use is one with either glass or metal barrel, of two to four ounces capacity, and having an angular tip of small diameter (Fig. 474). Other instruments for this purpose are the cotton-carrier, the probe, the blunt hook, the Gross ear-scoop and hook, and some form of ear-forceps. An ordinary steel cotton-carrier answers the purpose. In using it wrap a small pledget of cotton tightly, leaving about $\frac{1}{4}$ inch of the cotton beyond the end of the carrier to protect the canal-walls from injury. With this much loose débris can be easily mopped from the canal, as well as small quantities of pus, etc. As a rule, entirely too large a pledget of cotton is used: much better results can be obtained from a few small pledgets intelligently used in a well-illuminated canal than from an unlimited number of the large pledgets that are so much in vogue. The probe and blunt hook, as combined in the Hartmann instrument (Fig. 475), are very useful in clearing out a canal and investigating the condition of its walls as well as of the tympanic membrane. The Gross ear-scoop and hook, found in many of the minor surgical pocket-cases, is also a decided aid in many cases, but must be used with great caution and with good illumination of the canal. A good pair of ear-forceps is a necessity—their number and forms approach legion: that which has served me most usefully is the Hartmann dressing-forceps (Fig. 476).

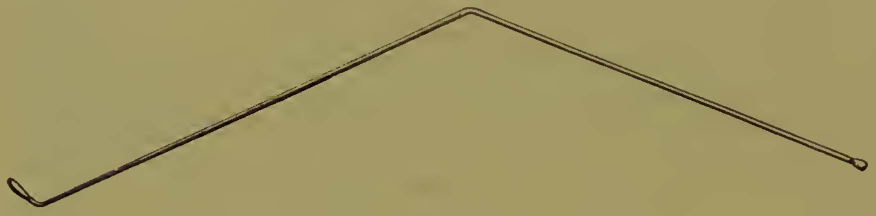

Fig. 475.—Hartmann's combined probe and blunt hook.

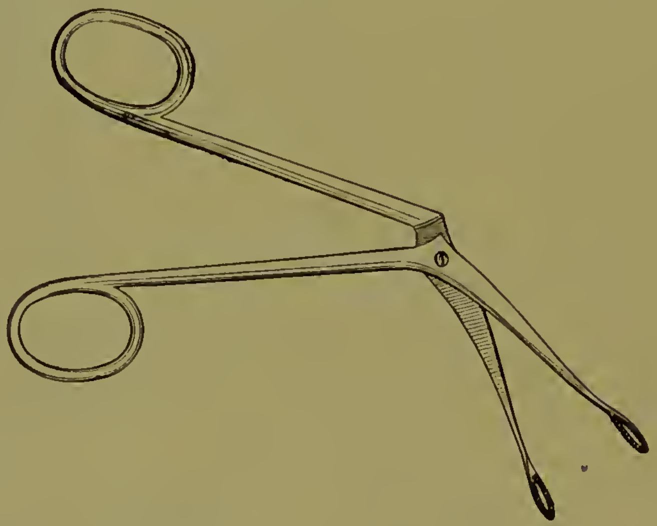

Fig. 476.—Hartmann's ear-forceps.

It may not be out of place to make one more general remark about all ear-instruments which permit of it—*i. e.* they should be bent at an angle of about 135°, instead of being straight, because this shape allows of easier and more skilful use, and avoids the objection which holds against all straight instruments—viz. that with them the index finger must of necessity intrude more or less upon the line of vision.

Source of Light.—In ear-work this is a matter of importance. Sunlight, daylight from a northern window, the reflection from white clouds, a white wall or fence, cannot any of them, be used at all times. Hence artificial light, which may be had constantly and of uniform intensity, must be our standby. The oxyhydrogen flame, the incandescent electric light, gas-light plain or modified by the Welsbach burner, the kerosene lamp, the old-fashioned tallow-dip, have all of them their uses; but for routine work my preference is for the Welsbach burner.

Technic of Examination.—The ear to be examined should be turned away from the light and toward the examiner, the light being about on a level with the patient's ear. The examiner should always use the same eye, thus training it to do the best possible work, and should with the chosen eye always make the observations through the perforation in the center of the head-mirror. The other eye should always be kept open, both to avoid fatigue and to locate the direction of the reflected light and to aid in focussing it more quickly upon the ear. This being done, the auricle, the concha, and so much as possible of the canal should be carefully observed before a speculum is introduced; otherwise affections of these parts may be hidden by the speculum and entirely overlooked. Should pieces of epithelium or cerumen be in the way, remove them carefully; should the canal-walls be found swollen, as from furuncle, introduction of the speculum may be too painful and have to be postponed; in such a case the evident swelling, together with the history, perhaps sufficing for a diagnosis.

Having the light properly focussed, and having chosen a speculum of appropriate size, it is introduced as follows: Seize the upper outer part of the patient's auricle, if the right one, between the middle and ring fingers, if the left one, between the index and middle fingers, of the left hand, and, supposing the case to be an adult, pull the auricle firmly upward, outward, and a little backward to straighten the canal; then with the right hand introduce the speculum, with a slight rotary motion, inward past the frequently existing hairs, etc. in the outer portion of the canal, and grasp it between the left thumb and index finger, the right hand being thus left free for other manipulations. Epithelial flakes, cerumen, pus, etc. obstructing the view must be removed by the appropriate instruments, so that an unimpeded view of the tympanic membrane may be obtained. An occasional difficulty is an unduly prominent antero-inferior canal-wall, but practice in changing a little the line of vision and the position of the speculum will overcome this. In exceptional cases the presence of the speculum in the ear gives rise to a troublesome ear-cough, and still more rarely to a feeling of faintness or positive fainting, or even to epileptiform attacks. As a rule, however, the patient becomes rapidly accustomed to the presence of the speculum.

Appearances of the Canal.—The epidermis lining the normal canal has an opaque whitish color. Under *pathological* conditions the walls may become hyperemic, may be the seat of localized or diffuse swellings, or may show serous or purulent excretions, ulcerations, or fistulæ, while the lumen of the canal may be more or less filled with serous, mucous, or purulent secretions, with collections of cerumen or thrown-off epithelium, with foreign bodies, or with tumors (exostoses, polypi, etc.) which arise either from its walls or from the tympanic cavity.

Appearances of the Tympanic Membrane.—The normal membrane is somewhat oval in shape, pearly gray in color, and translucent, with certain prominent landmarks—the short process of the malleus, antero-superiorly, looking much like a small pustule (*a*, Fig. 477), with the *manubrium* or handle of the malleus running from it downward and backward to the center of the membrane, the *umbo* (*i*); antero-inferiorly from this is the triangle of light, "cone of light," or light-reflex (*m*), due in shape and position to the concavo-convex face of the membrane and its general oblique position relative to the axis of the canal, whereby the rays of light from the observer's mirror strike only here upon a surface at right angles to the line of vision—the rule being that *any point which appears brightly illuminated is on a plane at right angles to the line of sight.* The margins of the membrane are set in the bony tympanic ring, which encircles it completely except at its upper part, where there is a notch, the notch of Rivinus. Filling in this space above the short process is the *flaccid membrane* or *Shrapnell's membrane*, separated from the other portion of the membrane, the *tense* or *vibrating membrane*, by the anterior and posterior folds (*e.g.*), whiter than the rest of the membrane and running forward and backward from just above the short process.

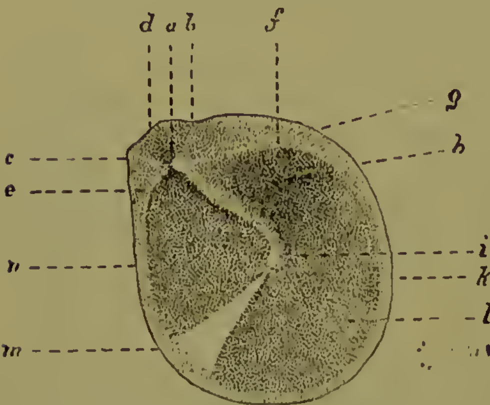

FIG. 477.—The normal drumhead.

Pathologically the tympanic membrane may present—

(*a*) **Changes in Color.**—The luster may be lost, with general dulness and indistinctness of the landmarks, from soaking, loosening, or thickening of the outer layer of the membrane (drops, syringing, superficial or underlying inflammation). *Opacity* results from thickening of any or all the layers, either of the whole membrane or of circumscribed yellow or white patches, single or multiple, large or small, due to fibrous or calcareous degeneration, and indicating, as a rule, severe preceding inflammation. A bright, coppery appearance is due to a congested tympanic mucosa. A dark, hair-like line, concave upward across the whole membrane or across either anterior or posterior half, or both (see Fig. 467), indicates fluid in the tympanic cavity. In hyperemia the individual blood-vessels, not normally seen, become visible along the malleus-handle (see Fig. 8, Plate 11) over Shrapnell's membrane, or radiating in a thick network over the rest of the membrane, which, in the higher grades of inflammation, becomes pink or even bright red, all the landmarks being lost.

(*b*) **Changes in Surface.**—The normally smooth surface of the membrane may become irregular through the projection of ecchymoses, vesicles, interstitial abscesses, granulations, polypi, or through the wrinkling due to large cicatrices, or to atrophy, or to loosening of the superficial epithelial layer, from disturbance of its nutrition, seen occasionally in acute underlying inflammation.

(*c*) **Changes in Position.**—The membrane may be retracted or bulged, either in part or in its entirety. Retraction, as a whole, is usually due to insufficient ventilation of the tympanic cavity, and is recognized by the following changes in appearance: the anterior half is thrown into deeper shadow;

the short process is unduly prominent, as are the anterior and, to a greater extent, the posterior folds; the malleus-handle is fore-shortened, the light-reflex lessened in size and brilliancy or absent, and at times the tympanic cavity's inner wall and other structures become unduly visible—viz. the promontory posteriorly, the round-window niche postero-inferiorly, and postero-superiorly the descending process of the incus, the head and posterior crus of the stapes, the tendon of the stapedius muscle, and, finally, the chorda tympani nerve crossing the tympanic cavity just below the posterior fold. Circumscribed retraction is due to the indrawing either of atrophic areas, which usually have ill-defined margins, or, much more frequently, of thin cicatrices, which may be large or small, single or multiple, adherent or non-adherent, with margins, however, as a rule, definite and cleanly cut. These localized depressions appear thinner, more translucent, and, when not adherent, more movable than the surrounding membrane, and they not infrequently present at their deeper portions a larger or smaller light reflex. Bulging of the membrane, either localized or general, is usually caused by fluid in the tympanic cavity.

(*d*) **Loss of Substance.**—Perforations vary in size from a pinhole to absence of almost the whole membrane. They may occur in any part of either the *vibrating* or the *flaccid membrane,* or be present in both simultaneously. They present as circular, elliptical, oval, kidney- or heart-shaped openings, through which the tympanic mucous membrane becomes visible. Two, three, or four perforations of the same membrane are occasionally seen, and among the great rarities may be mentioned the sieve-like perforations which at times accompany tubercular or diphtheritic otitis media. It should be noted whether the margins of the perforation are red and raw, as in recent active perforations, or white and cicatricial, as in permanent openings. In examining for suspected perforation it is of the greatest importance that the whole surface of the membrane should be swept over with the eye, particularly near the margins; and on no account should Shrapnell's membrane be overlooked, that part from which we obtain evidence of the most serious of middle-ear troubles (see Plate 11).

The diagnosis of perforations is, as a rule, easy, but is at times difficult, particularly so of the very small and the very large ones—in the former because the size permits the edges to completely overlie one another, making a diagnosis by unaided inspection at times impossible; in the latter, in which —*e. g.* the whole vibrating membrane, including the malleus-handle and short process, have been destroyed by the suppurative process, because we have not the edges of the perforation sufficiently in evidence to aid the eye to establish the two planes—that for the perforation margins and that for the inner tympanic-cavity wall. In the difficult cases the following aids to diagnosis may be mentioned:—1. A perforation whistle can usually be obtained by forcing air, by some of the methods to be described, from the nose, through the Eustachian tube, out through the perforated membrane. 2. If before using the air-douche in a given case the external canal is thoroughly dried, and after using it fluid is found, its presence is almost certain proof of a perforation. 3. Another proof is furnished by the passage of fluid into the naso-pharynx when syringing an ear. 4. A perforation is indicated by the presence of mucus in the water with which an ear has been syringed. 5. A pulsating light-reflex seen in the depth of a canal means with the greatest probability a perforated membrane.

To distinguish perforations from cicatrices and atrophic spots, in addition to the above guides, there are two instruments which, as *aids to* *diagnosis*, should be the constant companions of the aurist. The first of these is the *bent probe* and *blunt hook* (see Fig. 475), whose use is to determine the point of insertion, consistence and mobility of tumors or inflammatory new growths (polypi, exostoses, furuncles), to determine the presence of fistulous openings or of bone-caries, as well as by actual touch to investigate the surface of the membrane (perforations, etc.). The other instrument is *Siegle's pneumatic speculum*, or *suction speculum* (Fig. 478).

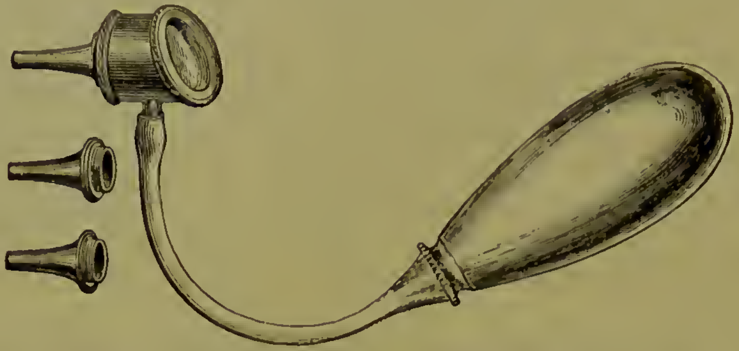

FIG. 478.—Siegle's speculum, the small end made to fit air-tight into the canal, and the large end closed by a glass set in at an angle and fitted with means to condense and rarefy the air in the auditory canal.

To the examiner illuminating the canal through the air-tight speculum will thus be disclosed whether the mobility of the malleus is impaired or whether the membrane is relaxed ; sunken cicatricial pouches can be distinguished from open perforations, adhesions of the membrane or of depressed cicatrices, or of the malleus-handle to the inner wall of the tympanic cavity can be made out; and not infrequently collections of pus in the attic or antrum can be detected and emptied by this apparatus.

V. EXAMINATION OF NOSE, NASO-PHARYNX, AND PHARYNX.

Since so many of the middle-ear diseases have their origin in the approaches to the Eustachian tube, the examination of the nose, naso-pharynx, and pharynx may well be made preliminary to an investigation of the middle ear. For the details of such examination the reader is referred to the appropriate chapters, special attention being given to the following points : 1. In the examination of the fauces, to the activity of the palatal muscles during phonation, these being also tubal muscles ; 2. To the appearance of the naso-pharynx, and especially of the mouths of the Eustachian tubes, by posterior rhinoscopy ; 3. To the patency of each nostril in relation to respiration, ventilation, and Eustachian catheterization.

VI. EXAMINATION OF THE MIDDLE EAR.

As preliminary to, and really a part of, investigation of the middle ear must first be considered the different means of determining the patency of the Eustachian tube. For the accomplishment of this, three methods may be used :

1. As giving a valuable preliminary idea of the condition of the tubes may be tried Politzer's experiment of holding a vibrating tuning-fork in front of the patient's open nostrils, when, during the act of swallowing, if the tubes are patulous, the vibrations are more distinctly heard by the patient. The rationale is of course plain : the act of swallowing opens the tubes when they are normally patulous, and the sound passes through them into the tympanic cavity. Negatively, if under these conditions the patient hears the

vibrations on one side only or fails to hear them on either side, it is evidence in the former case of tubal obstruction on the side on which the fork was not heard; in the latter case tubal obstruction on both sides is to be suspected.

2. **Inflation of the Ear, with Auscultation.**—Several methods of inflation are in vogue, with all of which auscultation may be carried out, with by far the most success, however, in the first method to be described —viz.:

A. **Inflation by means of the Eustachian Catheter.**—The instruments necessary for this are—(*a*) Eustachian catheter, made of metal or hard rubber (to the latter I give the preference), 5½ to 6 inches long, and made in three sizes; its last inch, the tip or beak, is gently curved till the point makes with the shank an angle of 140° to 150°; the large end is funnel-shaped to fit a corresponding tip on the air-bag, bottle, etc., and has on it a ring pointing in the same direction as the tip of the catheter. (*b*) An air-bag, single or double. (*c*) The auscultation-tube, which has been miscalled an "otoscope," consisting of a piece of light rubber tubing 24 to 30 inches long, having at the ends olive-shaped pieces—one white, the other black, so that they may be distinguished from one another, and the same one always used by the examiner. With this the sounds caused by the passage of air through the Eustachian tube into the tympanic cavity are observed. Before describing the introduction of the catheter the following general remarks may be in place: Catheterization should be performed with both patient and physician in the sitting position; the patient's head should be in such position that the floor of the nose will be as nearly as possible horizontal. While a head-rest is useful, it is by no means necessary; secretion should be, as far as possible, removed (by blowing, etc.) from the nose and naso-pharynx; a dash of cocain may without disadvantage be applied to the nostrils. The patient should keep the eyes open, should on no account hold the breath, but should breathe through the nose; it is well to occupy the patient's hands by giving them the air-bag to hold; then with the diagnostic tube in place, dip the already disinfected catheter into water or oil, blow through it to empty it and to see that the lumen is clear, and proceed *to introduce the catheter.*

With the fingers of the left hand resting on the patient's forehead and nose, where they should remain until the end of the procedure, the tip of the nose being moderately elevated by the left thumb, the catheter is held like a pen between the thumb and first two fingers of the right hand, and is entered, in almost a vertical position, into the nostril until the beak passes over the initial eminence on the floor of the nose. It is then rapidly brought to a horizontal position, and passed gently backward until the beak is felt to touch the posterior pharyngeal wall; if the catheter is brought too slowly to the horizontal position, the tip, instead of passing along the floor of the nose, may easily enter the middle meatus. Another important consideration is to hold the catheter as lightly as possible, not firmly grasped, when, with almost inappreciable force from behind, it will in the majority of cases find its own way through the nostril. Up to this point—viz. finding the posterior pharyngeal wall with the beak of the catheter—the two methods to be described of finding the mouth of the tube are identical. By the first and certainly the easier method the beak, as indicated by the ring at the outer end of the catheter, is turned toward the side to be catheterized into the fossa of Rosenmüller; it is then drawn gently outward for from ⅓ to ¾ of an inch, when the impression is given, and after a little practice readily recognized, of the beak turning downward as it passes the prominent posterior lip of the tube-mouth, followed, as it enters this, by a distinct feeling of turning upward again. It should now, the ring pointing toward the outer angle of the eye, be firmly grasped between the thumb and index finger of the left hand, the other fingers remaining in position on the patient's nose; the operator's hand, the catheter and the patient's head becoming thus, as it were, one body, so that movements of the latter do not displace the catheter. By the second method, instead of turning the beak of the catheter toward the side to be catheterized, it is turned toward the opposite side, drawn forward until the beak is felt to impinge against the posterior edge of the nasal septum, and is then rotated downward through an arc of 200°, when it will, as a great general rule, enter the mouth of the tube, and is to be grasped as before. Air is now blown through the catheter and Eustachian tube into the tympanic cavity, and the important information gained from the auscultation-tube is to be noted.

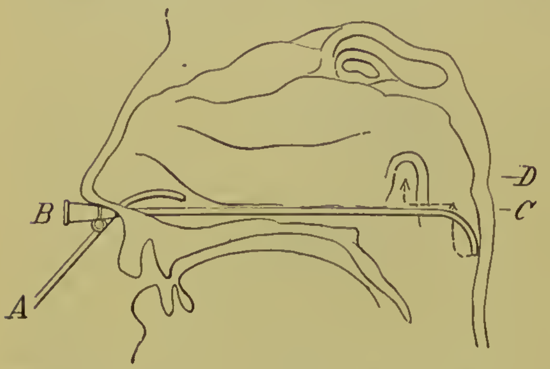

FIG. 479.—Introduction of catheter, first method.

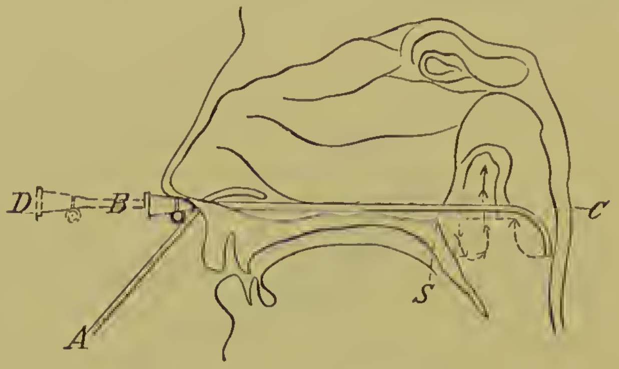

FIG. 480.—Second method.

Auscultatory Sounds.—These are produced either at the pharyngeal end of the Eustachian tube, in the tube itself, or in the tympanic cavity. With the parts in a normal condition there is heard with each compression of the air-bag a soft, dry, blowing sound, together with a slight thud or impact sound of the current of air against the tympanic membrane. Pathological conditions in the tympanic cavity, in the tube, or in the naso-pharynx change the character of the sounds heard in a more or less characteristic way—*e. g.* the crackling râles of fluid in the tympanic cavity, the whistle with a perforated membrane, the high-pitched rather distant sounds due to a narrowed Eustachian tube, the coarse distant rasping due to mucus in the pharyngeal end of the tubes. These sounds are worthy of careful study, practice enabling one to localize their source and to gain important knowledge of the conditions present.

Obstacles to Catheterization.—These are met with in the nose in the form of deflections, ridges, and spurs of the nasal septum; and in the naso-pharynx in the form of variations in the location and prominence of the pharyngeal extremity of the Eustachian tube in different cases; and on the two sides of the same case in the varying width of the naso-pharynx, and from muscular contraction due to the presence of the catheter in the naso-pharynx. Skill and patience will usually succeed in getting the catheter past the nasal obstructions; if not, a catheter with a larger curve to the tip may be passed through the other nostril. Delicate manipulation with differently curved catheters or with the same catheter differently moulded, at the same time insisting that the patient breathe through the nose, will overcome the obstacles met with in the naso-pharynx. Timidity of a patient when catheterized for the first time, and the discomfort to all patients in whom difficulties are encountered, may be greatly lessened or entirely avoided by the use of a small quantity of cocain solution.

Dangers of Catheterization.—Emphysema, even fatal in its consequences, has resulted from the use of the Eustachian catheter with highly condensed air; but with the hand apparatus, some form of which is at present almost universally used, even slight emphysema should never result. The experience of one of my colleagues leads me to utter a word of warning against the careless use of the catheter in elderly persons with fragile blood-vessels and an apoplectic tendency. A rare but not dangerous result of catheterization is severe dizziness or even momentary unconsciousness, due to sudden disturbance of labyrinthine pressure. It may be avoided by beginning the inflation very gently, when, if no unpleasant symptoms follow, the strength of the air-current may be increased. Another occasional result, never in my experience attended with serious consequences, is rupture of the tympanic membrane, although this accident is more frequent with Politzer's method of inflation.

Substitutes for Catheterization.—The other methods of inflation in common use are those known as Valsalva's and Politzer's.

B. **The Valsalva method** consists of an attempt to blow the nose with the mouth tightly shut and the nose closed with the finger and thumb, when, if one or both of the Eustachian tubes are normally patulous, the air will enter one or both of the tympanic cavities. This method has a certain diagnostic value, because it permits the examiner to watch the tympanic membrane during the act of inflation and to note the effect of the increased intratympanic pressure.

C. **Politzer's method** requires an air-bag, the Politzer bag (8 oz. capacity), and a nose-piece, preferably a conical hard-rubber one large enough to occlude one nostril, which is best connected with the air-bag by means of from 8 to 12 inches of rubber tubing. The idea of the original Politzer method and of its many modifications is to blow air into one nostril, the other being occluded, at the moment when the soft palate and uvula are by some maneuver forced back against the posterior pharyngeal wall, shutting off the naso-pharynx from the throat below it. Politzer accomplished this by having the patient take a small mouthful of water and swallow it at a given signal (nodding the head, the word "now," or counting up to three); simultaneously, one nostril being closed by the nose-piece of the Politzer bag, the other by pressure of the operator's fingers, the air-bag is compressed, when the air, being shut off from going elsewhere, passes through the Eustachian tubes and penetrates the tympanic cavities. Another plan, which almost always succeeds, and which I greatly prefer because of its freedom from discomfort to the patient, is to have the patient close the lips and puff the cheeks out forcibly, or he may be directed to utter in rapid succession the syllables "hick," "hack," "hock." The crying of very young children usually accomplishes the same purpose. Auscultation in the Valsalva and Politzer methods does not give very much information as to the condition of the middle ear, excepting only if there is a perforation of the tympanic membrane, when the perforation-whistle becomes very evident, often without, as well as with, the auscultation-tube.

Comparative Value of Catheterization and Politzerization.—Inflation with the catheter has, as a diagnostic measure, the following advantages over Politzerization: It enables the surgeon to measure the force needed to propel air into the tympanum; he can, by repeating the inflation, study the auscultation-sounds and make therefrom valuable deductions; it depends for success upon the skill of the surgeon, and not upon the patient's attempts to close the naso-pharynx. Catheterization of children under twelve years of age is difficult, however, and in them, fortunately, the Eustachian tubes being relatively shorter and of larger caliber, more information can be gained from the auscultatory sounds with Politzerization than in the adult. Hence Politzer's method as a means of diagnosis should be limited to children, and of course to those few adults in whom, owing to nasal obstruction, catheterization cannot be carried out. The diagnostic value of inflation lies in the comparison of the patency of the Eustachian tube and the effect produced, and has been so well summarized by Grant that I quote from him: "*Patency much diminished and improvement on inflation very considerable* would indicate a narrowing (catarrhal) of the Eustachian tube without significant tympanic disease. *Patency much diminished and improvement on inflation very moderate* would indicate simultaneous affection of the tube and tympanum, in the more favorable exudative form of chronic catarrh of the middle ear. *Patency normal and improvement on inflation little or none* would indicate a primary affection of the tympanum, as in the obstinate dry or sclerotic form of chronic catarrh. *Patency normal and hearing made worse by inflation* would indicate a healthy middle ear and pure nerve-deafness. *Immense improvement on inflation, followed by speedy or almost immediate return to the previous degree of dulness of hearing,* is characteristic of relaxation of the membrane."

3. **The Eustachian Bougie.**—The third method of investigating the patency of the Eustachian tube is that by means of the *Eustachian bougie.* If an obstruction exists, the procedures already outlined will have demonstrated the fact, the diagnostic use of the bougie consisting in locating the seat and degree of such stenosis. My preference is for the flexible, probe-pointed celluloid bougies, which come in four sizes. The smaller sizes should always be tried first. Before introduction two marks should always be made, with ink or otherwise, on the end of the bougie toward the operator, one indicating when it is leaving the catheter to enter the tube, the other, $1\frac{1}{4}$ inches farther back, indicating the point beyond which the bougie should not be introduced. The catheter having been fixed in the mouth of the tube, the bougie is passed rapidly down to the first mark, then very gently pushed farther, when, if it is entering the tube, the sensation conveyed to the finger becomes, after a little practice, easily recognizable, the patient having at the same time a sensation of sticking directly in the ear. If an obstruction is met requiring considerable force to overcome, the bougie must be withdrawn and a smaller one substituted. Stenoses are most frequent in the first inch (the cartilaginous portion), there being always moderate narrowing at the isthmus of the tube. Having thus located the stricture, and at the first attempt, or after repetitions gotten the bougie past it, air will be found to enter the tympanic cavity after its withdrawal much more freely than before. One precaution never to be forgotten is to examine the bougie carefully after withdrawing it, and, if the slightest trace of blood is found, *not to inflate,* thus avoiding the danger of emphysema. Another general precaution as to passing the bougie is that the whole operation must be performed with the utmost patience, gentleness, and caution, the patience extending, if necessary, to four or five sittings before the stricture is finally overcome.

No.

Name Age

Address Date

Occupation Nativity

Diagnosis

General Condition

Previous Treatment

A.S.		A.D.
	Pres. Comp.	
	Durat.	
	Tinn.	
	Pain	
	Disch.	
	Cause	
	Course	
	Heredity	
Remarks:		
	Peri-otic Region	
	Auricles	
	Ext. Can.	
	M.T. & Tymp	
	Eust. Tube	

			Before			
Speech	Whisper	Watch	T	Watch	Whisper	Speech
			After			

						Rinne						
						Before						
C^{-I}	C	C^{I}	C^{II}	C^{III}	C^{IV}	T	C^{-I}	C	C^{I}	C^{II}	C^{III}	C^{IV}
						After						

Notes.	Pol.H.M.	Galton	Pol.H.M.	Galton	Notes.
	Weber		Weber		

	RIGHT.	LEFT.
Ant. Rhinoscopy Sept, Turb. Meatus		
Post. Rhinoscopy Naso-Pharynx.		
Fauces Tonsils-Uvula.		

Mucous Membrane Generally

Treatment:

THE GENERAL THERAPEUTICS OF EAR AFFECTIONS.

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The therapeusis of disease in the ear, while conforming to that of surgical and medical practice in general, still presents certain points of difference which may be briefly noticed for practical purposes of reference.

In local medication departures from the general rules are necessitated by the peculiar structure of the external and middle ear, the comparative inaccessibility of the latter, its intimate relation to other important structures and cavities, and the necessity of choice made important by these conditions; while in general medication the internal administration of drugs, the selection and method of administration, have to be considered, not only in regard to the general therapeutic effect in which the ear may participate, but also with reference to the special effects which may be induced in the organ of hearing itself. In the local application for the treatment of eczema, for instance, while the rules to be observed are those which deal with the treatment of eczema in other parts of the body, attention must be paid to the fact that the external auditory canal is not only a passage which may be easily obstructed by the detritus of the skin mixed with a hard ointment, but that the lining of the canal itself is a skin which changes its characteristics from a thick hairy, glandular structure to a thin pavement epithelium within a shorter space than does the skin in any other part of the body. An example of general medication may be taken in that administration of pilocarpin which seeks to produce an effect in the limited area of the labyrinth at the expense of a very general constitutional disturbance.

Following the usual course of arrangement in treatises on diseases of the ear, and proceeding from without inward, the diseases of the external ear for which other than surgical treatment is demanded are anomalies of secretion, inflammations of the external ear and of the external auditory canal, eczema, herpes, lupus, and syphilitic inflammations.

The **anomalies of secretion** include, usually, the evidence of mechanical disturbance in the accumulation of the secreted mass, and a simple ceruminous plug mixed with particles of desquamated epithelium may sometimes require more than the use of warm water, which is usually its sufficient solvent, to effect its entire removal. Under these conditions the addition of sodium bicarbonate to the water used in syringing, or the previous instillation of some weak alkaline solution, properly warmed, or of a solution of potassium iodid in a mixture of equal parts of glycerin and water, will serve to facilitate the removal of the accumulation. In the cases of dense accumulations of epidermis where the ceruminous secretion serves only as a mask on the outer surface of the deeper-seated and more serious obstruction, or forms an unimportant element in the epithelial plug, it may be necessary, especially if the plug has been so long retained as to have become at all lardaceous, by the use of such stronger alkalies, as solution of caustic potash, carried on a cotton-tipped probe into the center of the mass, for the purpose of forming with the fatty acids resulting from the lardaceous degeneration of the epithelium, a soap which can be easily washed away, to favor the breaking up of the epithelial mass and its removal piecemeal by syringing or the forceps. In all cases of the use of the caustic potash in this manner the skin of the external canal should be moistened with weak acetic acid to neutralize the effect of any excess of caustic potash which would otherwise irritate the skin.

In the **fluctuating hyperemias of the auricle,** which are often a great source of discomfort in neurotic subjects, there is demanded not only the local application of cold and mild astringent solutions, but also an attention to the general health which comes more distinctly within the domain of the general practitioner; while for the chronic hyperemia the application of astringent solutions and of cooling ointments may be further accompanied by galvanization of the sympathetic.

As **primary erysipelas of the auricle** is very rare, and as the implication of the skin of the auricle occurs usually in the course of an attack of erysipelas originating elsewhere, the general treatment is that indicated by the demand for antipyretics and antiphlogistics; and the local treatment may be limited to the application of cooling solutions, antiseptic or astringent, as, for instance, of oleates and powders, oxid of zinc, and starch—exception being taken to such as discolor the skin, and thereby interfere with local observation of the progress of the case.

In the treatment of **eczema** the different manifestations of this skin-disease must be considered, and these vary not only with the stage of the disease, but in the external auditory canal with the portion of the skin implicated. At the outer end of the canal, for instance, where the skin is thick and studded with cerumen and oil-glands, a very considerable edema sometimes marks that stage of the affection in which the skin of the inner portion may be bathed in a serous exudation or firmly encased in dried serum crusts. In the moist stage the surface should be carefully dried and powdered, either with simple rice-powder or rice-powder mixed with equal parts of powdered calomel; and in the cases of intertrigo in children, in addition a light gauze compress may be placed behind the auricle, in order to support it and prevent the apposition of the denuded surfaces of the posterior portion of the concha and mastoid region. Where crusts have formed as a result of the drying of the serum mingled with the desquamated epidermis, they should be removed only with care, and may require softening to effect this, which may be done with vaselin applied by means of the cotton-tipped probe or a camel's-hair brush. After removal of the crusts the exposed parts should be smeared with a diachylon ointment or with some astringent ointment having vaselin for its base, the auricle being protected at night by compresses soaked in ointment, and the external auditory canal carefully anointed in a similar manner by means of a cotton-tipped probe. In cases of obstinate exudation at the inner end of the canal pencilling with weak solutions of nitrate of silver are of service, and this application is also especially useful in the squamous stage. Internal treatment, except in so far as directions as to general hygiene and diet are concerned, is rarely demanded, except in children, in whom the administration of tonics, especially iron, the iodids, and arsenic are sometimes indicated.

Herpes, which is an exceedingly rare disease and which requires very little local attention, is accompanied by very severe pain, which may be sometimes relieved by local application of solutions of cocain, or, in default of the operation of the local remedy, by the internal administration of a narcotic.

In cases of **lupus**, in addition to, or sometimes as a substitute for, the surgical procedure of curetting, applications may be made of caustic potash, nitrate of silver, or of the thermocautery, the surfaces to be treated having been previously cocainized.

The most common manifestations of **syphilis** in the external ear are those occurring in the form of condylomata and ulcerations of the external canal, which require, in addition to the general treatment, cauterization of the granulations with silver and dusting with calomel, the latter powder being especially useful in cases in which the granulations and ulcerations are accompanied by an eczema of other and adjoining portions of the skin.

In **furunculosis** of the external canal, in addition to the surgical treatment and the application of ear-baths, carbolized oil or oleate of morphia saturating a soft pledget of absorbent cotton, is of service. The possibility of infection from the micro-organisms which have been found in the boils should always be borne in mind; and where this is the case instillation of sublimate alcohol, of borated alcohol, and insufflation of boric acid should be resorted to in addition to the surgical treatment. After subsidence of the follicular inflammation the skin is very apt to be somewhat thickened, dry, and desquamating, and there is, as would be expected under these circumstances, often considerable itching, the attempt to relieve which by ordinary methods of scratching or rubbing often serves only to bring about a further infection of the skin and a repetition of the furunculosis. Under these conditions, the gentle application, on a cotton-tipped probe, of an ointment of salicylic acid and tincture of benzoin with vaselin, lightly smeared over the skin, is often of service; while other interference on the part of the patient than this should be limited to pressure upon the tragus or rubbing only of the external ear.

Diffuse inflammation of the external canal usually occurs as the result of injury or in the course of a follicular inflammation. The prognosis is speedily favorable, and treatment, in addition to instillation of warm antiseptic solutions and cold applications about the ear, may include the application of leeches in front of the auricle in the severe cases, or the more distinctly local phlebotomy of incisions into the skin of the canal itself.

The **plant-growth** most commonly found in the external auditory canal is the aspergillus, but in all cases of parasitic otitis externa the prognosis is good, as the plant-growth is speedily and effectually removed by frequent and judicious syringing, and, after drying of the ear, the instillation of alcohol and the insufflation of powdered boric acid.

In **acute inflammation of the middle ear** internal medication sometimes plays a very important part when it is made to include the attention which should be given to the general causative condition, as well as to the local manifestation in the ear.

In the acute congestion of the tympanum accompanying the closure of the Eustachian tube, incident to coryza in childhood, as well as in the congestions which occur in the course of the exanthemata, bromid of potassium or of sodium, given in small and repeated doses, is an important adjuvant to other treatment; while in more prolonged congestions of the lining membrane of the mastoid cells consequent upon acute otitis media in the adult, a small and continued dose of calomel has seemed to have a favorable effect.

So large is the supply of blood to the lining membrane of the tympanum and mastoid cells, and so subject is it to vaso-motor influences, that the demand for relief in acute cases is one which sometimes requires medical as well as surgical interference; and, while the latter affords certainly the readiest and often the most efficient remedy, the fact that the intimate relationship of the middle ear through the circulatory and nervous systems with the general economy makes the influence to be exerted upon it by general medication a peculiarly favorable one. The experiment of Roosa and Hammond upon the effects of quinin internally, as shown by ocular observation of the blood-vessels in the tympanic membrane, is an illustration of the effect of a drug internally administered under actual observation of its ultimate effect; and similar observations upon the action of bromid of potassium in cases of artificially produced congestion of the middle ear show that while the larger doses, from 15 to 50 gr., according to the age of the patient, produce a more immediate effect in the lessening of the capillary circulation, the smaller and continuous doses, from 1 to 5 gr. every hour, have a cumulative effect in the same direction, which is desirable in the more protracted cases. In the simple, uncomplicated acute congestion of the middle ear in childhood, in addition to the administration of the bromids, there may be instilled into the painful ear, providing always that no perforation of the tympanic membrane exists, the solution of sulphate of atropin in equal parts of glycerin and water—the purpose of this mixture being to provide a fluid which shall not only retain heat, but shall furnish on the outside of the tympanic membrane a fluid of greater density than the serum, and one which, therefore, will favor exosmosis through the dermoid layer; while such absorption of the atropia as is possible under the conditions of blood-tension tends to allay pain. How far the relief experienced in the cases of acute earache in childhood on instillation of this solution of atropia, as recommended by Theobald, is due to the absorption of the atropia, and how much to the simple effect of a warm application, it is impossible to say; but the clinical observation of its use certainly commends it. Where there is much swelling of the nasal mucous membrane, with acute closure of the Eustachian tube, the intranasal injection of a few drops of a weak solution of cocain, by causing temporary subsidence of congestion and swelling, favors the opening of the Eustachian tube, the drainage of fluid from the middle ear, and makes inflation by means of the Politzer air-douche or catheter more easily possible. The treatment here indicated applies equally to those cases of implication of the middle ear in the acute stages of the exanthemata, but internal medication may be of service also in the aural sequelæ of these diseases. In the persistent swelling of the tympanic mucous membrane which sometimes follows measles in young children, and which apparently lays the foundation for a permanent and progressive thickening of the mucous and submucous tissues of the middle ear in later life, the administration of the iodids, or, preferably of the syrup of hydriodic acid, is apparently of marked benefit: the administration of the latter drug may begin shortly after recovery from measles. It should be given in doses of a teaspoonful twice or thrice daily between meals, and in prescribing may be combined with one-fourth part of sherry wine or other alcoholic stimulant. The effect of the drug should be watched, and in the event of the appearance of an acute coryza or facial eruption its use should be suspended until these symptoms have disappeared; and, as a rule, better effects are obtained by giving it only two and three weeks at a time, with intervals of one and two weeks' abstention. This same remedy has also been found useful in the cases of nasal and naso-pharyngeal catarrh which are apt to have an important and deleterious influence upon the middle ear; and even in adults in cases of chronic catarrhal inflammation, with gradual thickening of the mucous membrane in the tympanum, the continued use of the syrup of hydriodic acid has seemed to be of service.

In cases of **acute perforation of the tympanic membrane** in very young children, as well as in the suppurative processes accompanying and following the acute exanthemata, more especially scarlet fever, local medication, which accompanies the process of cleansing, needs to be adapted to one or more of two or three conditions. In the serous discharge from the ear which in infants, mingling with the particles of desquamated epidermis in the canal and with light-colored cerumen, often, to superficial observation, simulates pus, syringing with a warm weak solution of the sulphocarbolate of zinc is more serviceable than the alkaline washes, because the congestion at the inner end of the canal incident to the congestion of the middle ear favors an exfoliation of the delicate epidermis, and renders a slightly astringent application acceptable. In cases of perforation, with distinct mucous or muco-purulent discharge from the ear, especially if the discharge has, as is not infrequently the case, a slightly acid reaction and an irritating effect upon the skin of the external canal, syringing with mild alkaline waters or with a weak solution of bicarbonate of soda has often a more serviceable effect than the use of astringent solutions or the insufflation of astringent and antiseptic powders. In this connection it may not be improper to express an opinion in regard to the forcible inflation of the middle ear by Politzerization in cases of acute suppurative inflammation of the middle ear with perforation of the tympanic membrane in very young children. This procedure, which is sometimes strongly advised, and which has for its purpose the passage of a column of air through the Eustachian tube into the middle ear and out through the opening in the tympanic membrane, carrying with it the accumulated products of the mucus-secreting glands, and of a suppurative process—while effective in its purpose in temporarily emptying a cavity of small capacity—subjects the structures of the middle ear to an indefinite degree of disturbance; and the cavity, moreover, if the secretion is copious, immediately refills. Where the perforation in the tympanic membrane is sufficient to permit a free egress to secretions from within, the outflow of fluid will correspond in degree to the degree of its production; and the complete emptying of the cavity, therefore, has for its purpose the opportunity afforded for the intratympanic instillation of medicated solutions which may have a favorable and deterrent effect upon the freely secreting lining of the middle ear. The attempt to effect both these purposes, as proposed by Van Millingen, in syringing through the Eustachian tube into the middle ear, with exit for the fluid through a perforation in the tympanic membrane, was found to result in a degree of violence to the affected parts entirely inconsistent with their delicacy of structure. In the acute suppurative process in the middle ear, both in children and in adults, it being had in mind that congestion and edematous infiltration are prominent conditions of the early stages, it stands to reason that palliative measures, both local and general, are first in order. Locally, these may include, in addition to the direct surgical phlebotomy, the instillation into the ear of mild alkaline and antiseptic solutions, the application of dry warmth or, in cases of early mastoid congestion with pain and rise of temperature, the application of cold to that region either by means of compresses, the ice-bag, or the Leiter coil, with internal administration of the bromids, of opiates, if necessary, of saline laxatives (upon the value of which much stress is laid by the early English authorities), and the observance of a light, non-stimulating diet. In these cases in the adult also the freeing of the bowels, followed by the continuous administration of a mild laxative like calomel, is apparently a useful adjuvant to other treatment. The use of calomel in the small and continued dose in cases of localized inflammation was suggested by the late Dr. E. H. Clarke, whose administration of this drug was based upon long experience at a time when a much higher value was put upon its effect than at present obtains.

In **chronic suppurative disease of the middle ear,** in addition to the ordinary cleansing process for the removal of the discharge both from the external and middle ear, and the use of the alkaline solutions for that purpose, as already indicated in the more acute cases, it is sometimes necessary to apply astringent solutions or powders for the purpose of acting upon the inflamed or ulcerated surfaces of the mucous membrane of the middle ear or the dermoid lining at the inner end of the external auditory canal, or to act as a deterrent to the undue formation of granulomata. In all cases, after the cleansing has been effected either by the ordinary syringe or the middle-ear syringe, the surfaces to be medicated should be dried as thoroughly as possible by means of a cotton-tipped probe or by pledgets of absorbent cotton; and in old cases of chronic suppurative disease, especially where the epitympanic space has become involved or where there are evidences of caries of the bony wall of that cavity or of the ossicles, the drying process should be made the occasion for a careful examination of the parts with a view to more direct local application of astringents, acids, or other escharotics.

In the **simple uncomplicated chronic suppurative disease,** after cleansing and drying, insufflation, with or without packing, of antiseptic powders, preferably boric acid, acetanilid, or a combination of the two, may, suffice as treatment; although the instillation of a saturated solution of boric acid in alcohol or of alcohol alone diluted with water to a point at which it can be easily borne in the ear, will serve to shrink the smaller granulomata, which, springing from ulcerated surfaces, both tend to increase the volume of purulent discharge and sometimes, by their unfavorable position to block its exit. Further and localized applications to the granulations or polypi may be made by use of a saturated solution of nitrate of silver on a cotton-tipped probe, or of such astringents as muriated tincture of iron, ferric alum, or, in the case of firmer polypi, of escharotics; while weak sulphuric acid, the contiguous surfaces being guarded by moistening them with a weak alkaline solution, may sometimes be employed as an application to carious bone and as a substitute for the use of the curette.

In cases of **chronic non-suppurative disease of the middle ear** local medication, except such as is limited to applications through the Eustachian tube, is of comparatively little service, unless we may include under this head the mechanical operations which affect the circulation in the tympanic membrane and the middle ear, such as the use of the Politzer method of an air-tight seal at the outer end of the external auditory canal, absorption of the enclosed air by the dermoid lining of the canal producing a partial vacuum. This not only results in a preponderating atmospheric pressure on the inner surface of the drumhead, but also in an increase of the capillary circulation of the lining, not only of the external canal, but also in a lesser degree of that of the middle ear. The various processes of massage, having for their purpose an increase in the mobility of the drumhead and other portions of the sound-transmitting apparatus, tend also by increasing the circulation in these parts to stimulate the absorbent glands, and so favor a decrease of the thickening already existing in the mucous and submucous tissues of the middle ear.

In the course of a **progressive non-suppurative middle-ear disease,** however, general medication and attention to general hygiene sometimes play an important part, since the effects of faulty nutrition which result from general overtire and nervous overstrain, increased still further by the fatigue incident to a considerable degree of deafness, interfere with the nutrition of the more delicate structures of the body, and so favor trophic changes which are evidenced in the ear by still further impairment of hearing. The circulatory tinnitus, which accompanies many cases of chronic progressive middle-ear disease, often becomes an important factor in the general nervous condition of the patient; and remedies tending to decrease the cerebral circulation or to lessen the sensibility of the nervous system are often of important temporary benefit. This is especially the case where the neurasthenic condition makes both the impaired hearing for sounds aërially conveyed, and the correspondingly increased hearing of the cerebral and intra-aural circulation a matter of grave annoyance and sometimes of detriment. While they need not be specified here, the measures applicable to the treatment of abnormal conditions in the nose and naso-pharynx are very important considerations as a part of the treatment of the aural disease.

In **diseases of the internal ear** where local medication is out of the question, and dependence for an effect upon this portion of the organs of hearing and of equilibration must be placed upon such drugs, internally administered, as materially affect the circulation in these parts, the range of remedies at our disposal is necessarily limited—aside from those which may be employed in improving the general hygienic condition of the patient. One decided exception must be made in those cases of syphilitic disease of the labyrinth where, in the event either of an affection of the cochlea with impairment of hearing, or of the semicircular canals with disturbance of equilibrium, prompt administration of the iodids and mercurials sometimes has a markedly favorable effect: as has been shown by Politzer and other observers, the use of muriate of pilocarpin in these cases is also especially serviceable. In the non-specific cases of high grades of deafness and vertigo the drug must often be administered for a longer time and in larger doses than in the specific cases; and Dr. Gorham Bacon cites a case of a high degree of deafness, with vertigo, following a chronic suppurative disease of the middle ear in a man of middle age, in whom the daily administration of this drug in gradually increasing doses up to three-quarters of a grain finally resulted in a marked improvement in hearing and in stability. In simple congestion of the labyrinth, remedies which serve to decrease the cerebral and also the intralabyrinthine circulation, such as the bromids and ergot, and in cases of anemia, tonics and stimulants are indicated; while in cases of auditory vertigo, with occasional sharper vertiginous attacks, consequent upon sudden suspense of vaso-motor inhibition, the sulphate of quinin, given in the small and continued dose, is often of value in equalizing the circulation.

AFFECTIONS OF THE EXTERNAL EAR.

By SAMUEL THEOBALD, M. D.,

OF BALTIMORE, MD.

Diseases of the external ear—that is to say, of the auricle and external auditory canal—constitute about 26 per cent. of the total of affections of the auditory apparatus as met with in hospital practice;[1] diseases of the auricle are of comparatively infrequent occurrence, and make up but 2 per cent. of the total; while affections of the auditory canal are common and constitute about 24 per cent.

AFFECTIONS OF THE AURICLE.

Congenital Malformations.—Many minor congenital defects of the auricle have been described, such as anomalies of the helix, the antihelix, the lobule, the tragus, etc., but they are not of sufficient importance to demand here especial consideration. The major defects, such as microtia and polyotia, have frequently associated with them anomalous conditions of the auditory canal (atresia, etc.), and even of the middle and internal ear. They may be unilateral or bilateral, and are said to be due to incomplete closure of the two upper branchial clefts, insufficient turning up of the auricle during its development, etc.

Microtia.—In pronounced cases of this defect the auricle is so misshapen and rudimentary as to present scarcely any resemblance to the normal ear, and in some instances the deformity involves the face as well as the ear. The condition is well shown in the accompanying illustration (Fig. 481), for which, as well as for a number of other illustrations in this article, I am indebted to Dr. Randall. The changes of form are manifold and at times fantastic. Knapp, for example, has met with cases in which the rudimentary auricle was hook-shaped or spirally curved, and other cases have been reported by Moos and Steinbrügge in which it resembled a cauliflower excrescence.

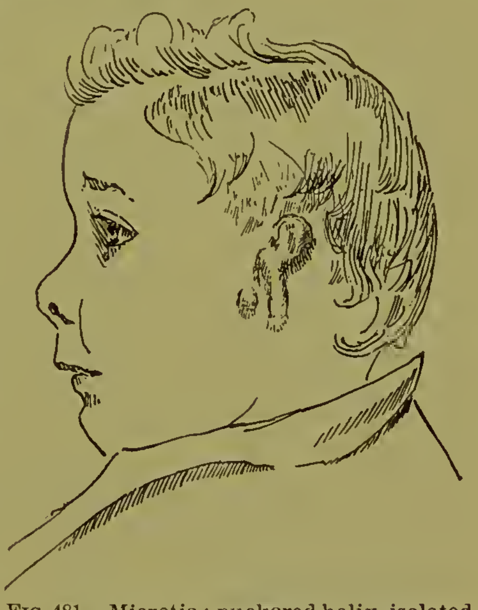

Fig. 481.—Microtia: puckered helix, isolated tragus, and imperforate meatus.

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[1] Based upon analyses of 19,568 cases—9670 observed at the Newark Eye and Ear Infirmary, 4486 at the Baltimore Eye, Ear, and Throat Charity Hospital, and 5412 tabulated by Dr. Randall, from his practice. At the Newark Infirmary diseases of the external ear comprised 30 per cent. of the total; at the Baltimore Eye, Ear, and Throat Hospital, not quite 28 per cent.; and of Dr. Randall's cases, 17½ per cent. Diseases of the auricle constituted not quite 1½ per cent. of the total at the first-named institution, slightly more than 3 per cent. at the second, and a little over 1½ per cent. of the cases tabulated by Dr. Randall.

Polyotia.—This term is applied not only to cases in which two or more auricles exist upon the same side, but also to cases of microtia which are accompanied by multiple growths in the immediate neighborhood of the auricle, but distinct from it. The most common form is that of a wart-like excrescence or more complex "auricular appendage" situated upon the cheek in front of the external meatus (Figs. 482 and 483). These multiple growths, in exceptional instances, are found associated with a normal auricle.

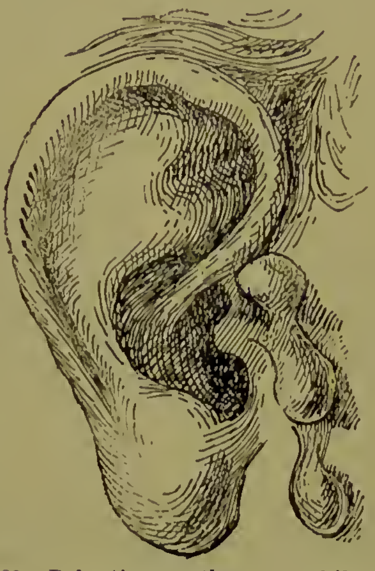
FIG. 482.—Polyotic growth present bilaterally in a woman of 22.

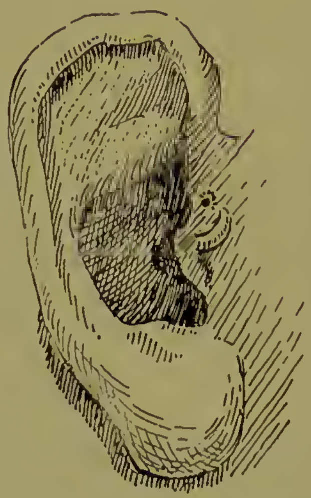
FIG. 483.—Horn-like auricular appendage with congenital aural fistula.

Cartilaginous outgrowths from the auricle, known as *auricular appendages*, are occasionally met with, their most frequent location being upon the tragus (Fig. 483).

Congenital fissure or cleft of the lobule has been observed, and is said by Politzer to be "quite common,"[1] a statement which, as to this part of the world at least, hardly holds good. A variety of *congenital fistula*, usually located just above the tragus (Fig. 483), and said by Burnett to connect in some instances with the tympanic cavity, is an anomaly of not very infrequent occurrence. Dench describes a case which presented an opening about one-sixth of an inch in diameter, into which a probe could be passed to the depth of half an inch.[2] Retention-cysts have been known to develop in them, and they may be the seat of purulent inflammation. The depth is usually slight and the direction downward and forward.

The writer has met with an instance of marked congenital difference in the conformation of the right and left auricles, one being larger and more prominent than the other, in which the defect was transmitted, although in a less noticeable degree, to the children and grandchildren—an appreciable difference in the auricles being observable in four out of six children and in several grandchildren.

As to the **treatment** of congenital anomalies of the auricle there is not much to be said. Auricular appendages, supernumerary auricles, and multiple growths about the ear may be readily removed, and cleft of the lobe may be satisfactorily dealt with by operation; but attempts to remedy by operative procedure, plastic or otherwise, the more grave defect of microtia have been attended by very unsatisfactory results, and in high degrees of this deformity removal of the rudimentary auricle and the substitution of an artificial ear are recommended. Congenital aural fistula does not require treatment unless it be the seat of inflammatory or other changes. Undue prominence of the auricle, if seen in infancy, may be corrected in great measure by any simple device which will keep the ear constantly in close apposition with the side of the head. Glueing the auricle to the head with collodion has been recommended. In adults such procedures are ineffectual, and the operation described on page 783 is called for.

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[1] *Diseases of the Ear*, Eng. trans., Philada., 1894, p. 698.

[2] *Diseases of the Ear*, New York, 1895, p. 179.

Eczema of the Auricle.—This is a condition of frequent occurrence, especially in ill-nourished, strumous children. It often exists in association with phlyctenular ophthalmia, and under such circumstances may be accompanied by suppurative middle-ear inflammation. In adults the auditory canal is usually involved in the inflammatory process, and the disease, which is frequently dependent upon a gouty diathesis, is less amenable to treatment than it is in children. In bad cases the whole auricle, and the neighboring portions of the scalp as well, may be affected, but oftener the inflammation is limited to the line of juncture of the auricle with the head, to the concha, and to the fossa helicis.

The **treatment** should be directed to the general condition of the patient as well as to the local affection. In adults the probable existence of lithemia should be borne in mind, and the patient's diet and his bowels should be regulated, and the remedies usually employed to combat this condition should be prescribed. In children a brisk calomel cathartic is often indicated, to be followed by the administration of the elixir or the syrup of the phosphates of iron, quinin, and strychnin—a much more efficacious remedy, in the writer's experience, than the more frequently prescribed syrup of the iodid of iron. The most useful local remedies are the oxid of zinc with boric acid and the yellow oxid of mercury. The latter should be used in the form of an ointment (gr. ij to ʒj), and the former either as an ointment (1 drachm of powdered boric acid being added to an ounce of the officinal oxid-of-zinc ointment) or as a powder (equal parts, by weight, of boric acid and oxid of zinc), to be dusted upon the auricle, and, when indicated, blown lightly into the auditory canal. When scabs are present they should be removed by maceration as a measure preliminary to other treatment. Painting the affected part with a solution of nitrate of silver (gr. x–xxx to ℥j) is a remedy which is at times of value, especially in the moist conditions, and subnitrate of bismuth (in ointment or powder), oil of cade, salicylic acid, aristol, and the different preparations of lead are remedies which may be tried should those first named fail to effect a cure. A tendency to relapse is characteristic of the disease: too early discontinuance of the treatment, therefore, is to be avoided.

Herpes zoster of the auricle is a rare condition, but cases have been reported by J. Orne Green, C. H. Burnett, Anstie, Auspitz, Gruber, and others.

Erysipelas of the auricle is occasionally encountered, usually as an extension of facial erysipelas. The indications for treatment are the same as when these affections occur in other regions of the body, and there is nothing in their clinical course worthy of especial note.

Abscess of the auricle, especially of the lobule, where it is often the result of piercing the ear, and where, particularly in the colored race, it may become cystic, is of rather common occurrence. It is also a usual accompaniment of perichondritis (Fig. 484).

The **treatment** consists in free incision, which in the cystic cases may require to be supplemented by curetting or, better still, by cauterizing the cyst-wall with a bead of nitrate of silver fused upon the tip of a probe.

Perichondritis of the Auricle.—This condition is commonly of traumatic origin, but may be due to the extension of inflammation from the auditory canal, while occasionally it occurs without evident cause. The idiopathic cases are usually met with in persons who are in a poor state of health and in whom there is general malnutrition. Its starting-point under such circumstances is probably in certain degenerative changes in the cartilage, which have been described by Ludwig Meyer and others, and to which the name chondromalacia has been given (Buck). The traumatic cases usually owe their origin to blows, or may arise from exposure of the auricle to extremes of heat or cold (as in frost-bite). The symptoms are a burning sensation in the ear, followed by severe pain, which is accompanied by swelling and marked injection of the auricle. The swelling, which may increase until the normal configuration of the auricle is completely obliterated, is due to an effusion of fluid—usually serous at the outset, but tending quickly to become purulent—beneath the perichondrium. The ear feels hot, and is often very sensitive to the touch. Left to itself, the fluid tends to escape spontaneously, but may be slowly absorbed. A high degree of deformity of the auricle is a frequent consequence of uncontrolled perichondritis (Fig. 485).

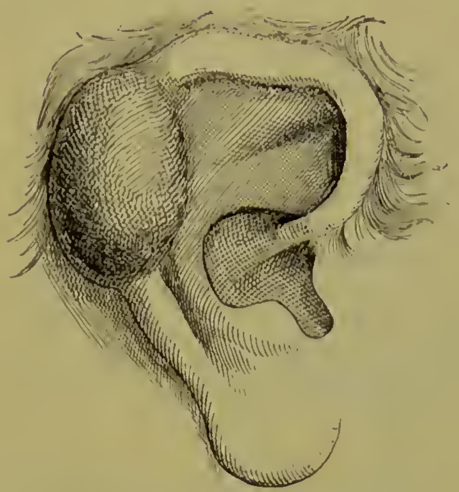

Fig. 484.—Abscess of margin of helix; sequel of hematoma in pertussis.

An effusion of blood, more or less extensive, between the perichondrium and the cartilage (*hæmatoma auris; othæmatoma*) (Fig. 486) is a not infrequent accompaniment of perichondritis, usually preceding the onset of the inflammatory process in traumatic cases (being a direct consequence of the injury), and following closely or accompanying it in non-traumatic cases. The etiology and pathology of this condition have been widely studied,

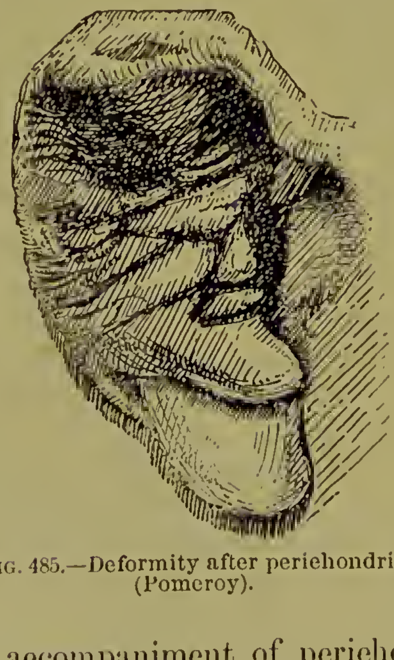

Fig. 485.—Deformity after perichondritis (Pomeroy).

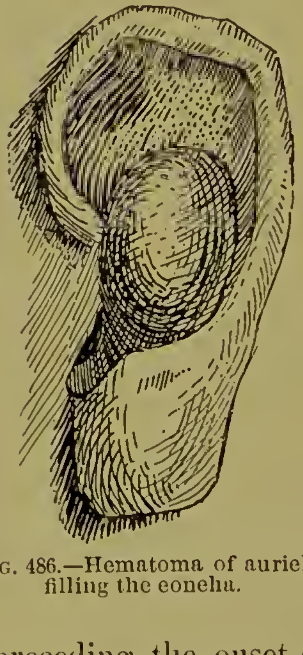

Fig. 486.—Hematoma of auricle filling the concha.

especial interest attaching to the subject because of the frequent occurrence of tumors of this character in the insane. Some investigators have attempted to explain this association upon the theory that hematoma auris is usually of traumatic origin, and that the insane are especially liable to injuries such as might give rise to it, either self-inflicted or received through efforts to control them. Others maintain that the lesion is more directly connected with the insanity of the subject, and that it is dependent upon the pathological condition of the brain; while Virchow, Ludwig Meyer, Pollak, and others contend—and apparently with greater justification, since their views are based upon more exact pathological study—that it has its origin in degenerative changes found in the cartilage of the auricle, not only in the insane, but in other ill-nourished individuals as well—changes which they point out are accompanied by the development in the neighboring tissue of capillary vessels of unusually large size and having very thin walls. With such conditions as these existing, it can be readily understood how hemorrhage might result from the most trivial violence to the auricle or even without such provocation.[1]

Treatment.—If seen at an early stage, the application of cold in the form of the aural ice-bag may be productive of good results in acute perichondritis. If, in spite of this measure, the effusion beneath the perichondrium increases, aspiration may be resorted to under strict antiseptic precautions, to be followed by the application of firm pressure upon the auricle, to prevent if possible—what is very apt to occur—a re-effusion of fluid into the aspirated cavity. Should the fluid reaccumulate after, perhaps, a repetition of the aspiration, or should suppuration supervene, the sac must be laid open by a free incision and packed with iodoform gauze. Should necrosis of the cartilage have occurred, the necrotic parts must be thoroughly removed by curetting. The application of tincture of iodin to the cyst-like walls of the cavity may be called for to promote its obliteration. Massage is useful after healing has taken place or to bring about the absorption of inflammatory products when incision has not been resorted to; and the external application of iodin is also of value under similar circumstances.

In hematoma compression and massage may be tried if the tumor be small. If it be of considerable size, aspiration, followed by compression, may be employed, or the sac may be freely opened and dealt with as a perichondritis unaccompanied by extravasation of blood. Tonics and a change of diet are usually indicated. The likelihood of considerable deformity of the auricle resulting, even when the case has been judiciously treated, should not be lost sight of, and should be impressed upon the patient.

Syphilis of the Auricle.—The primary lesion of syphilis, as might be supposed, is rarely located upon the auricle, yet cases of this character have been reported by Pellizzari, Zucker, Hermet, and others, the cause of the infection being usually a bite by a syphilitic individual. The eruptions of secondary syphilis are frequently observed upon the auricle, accompanying similar eruptions upon the face and scalp. Gummata and syphilitic ulcerations are rare, but cases have been observed by Buck, Burnett, and Politzer.

The indications for **treatment** are simply those which apply to syphilis affecting other portions of the body.

Lupus.—In lupus vulgaris of the face the auricle is frequently involved, but cases in which this disease originates in or is confined to the auricle are extremely rare. The auricle may be affected in any of the various types of lupus. In the ulcerative forms of the disease it may be partially or even totally destroyed, and the auditory canal and middle ear may be invaded.

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[1] For a fuller consideration of this subject see *Manual of Diseases of the Ear*, by Dr. Albert H. Buck, p. 56 *et seq.*, New York, 1895.

Treatment.—In removing the diseased tissue with the curette, the galvano-cautery, or with caustics, care should be exercised not to sacrifice healthy structures, otherwise marked deformity of the auricle will ensue. To prevent involvement of the auditory canal and deeper structures of the ear, complete removal of the auricle may at times be required.

Frost-bite.—In cold climates frost-bite of the auricle is of common occurrence, and even actual freezing of the ear may take place. Under such circumstances the auricle may become fragile, and must, therefore, be manipulated with care.

In the **treatment** of this condition, to prevent too sudden reaction, it is advised that the ear should be "thawed out" gradually by the application of snow, pounded ice, or cold water, the individual being kept for a time in a cold room or even out of doors. Subsequently the case must be treated much as one would treat a burn—by the application of an emollient, such as linseed oil and lime-water or vaselin. Perichondritis, with more or less extensive necrosis of the cartilage, may result from prolonged exposure of the auricle to cold.

New Growths of the Auricle.—The auricle is occasionally the seat of malignant as well as of benign tumors. The most frequently met tumor of the auricle is **fibroma** or **keloid.** It is usually located in the lobule, and owes its origin almost always to the operation of piercing the ear or to the irritation accompanying the wearing of an ear-ring. It is of especially frequent occurrence in the negro race (Fig. 487), and is said to exhibit a decided tendency to recur after removal, although the writer's experience with such growths—not very extended, it is true—would not lead him to endorse this view. The tumor is quite firm and the surface is usually nodular. Both ears are not infrequently affected, the exciting cause in each instance being the same.

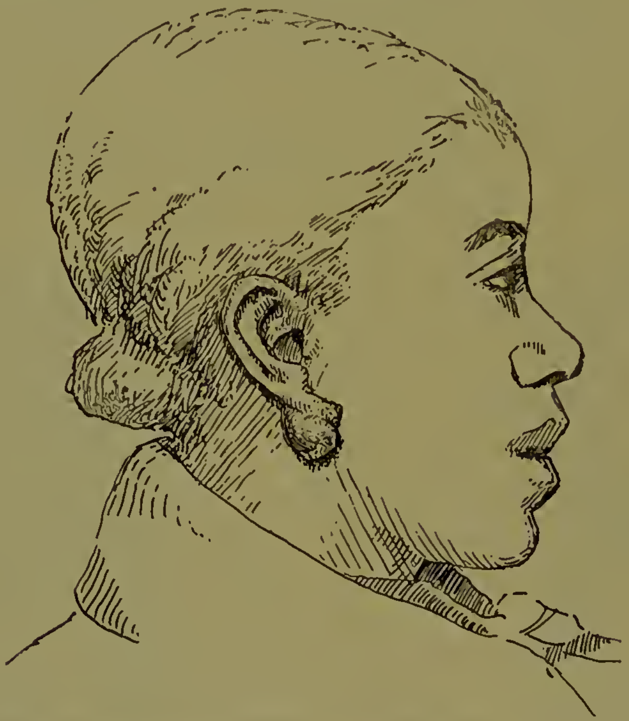

FIG. 487.—Fibroma (keloid) of lobule (bilateral) in a negro girl after piercing for ear-rings.

Other benign growths which have been observed are *lipoma*, *angioma*, *papilloma*, and *sebaceous cyst* (see Fig. 462).

Horny Growths springing from the auricle have been encountered by Buck, Burnett, Pomeroy, Roosa, and others. In a case reported by Buck the growth, which was attached to the upper and posterior portion of the helix, is described as "a blunted, horn-like protuberance, $\frac{3}{4}$ inch long and nearly as broad at its base." The writer has never met with a growth of this character upon the ear, but several years since saw a precisely similar growth upon the upper eyelid near its free margin. It was somewhat curved, nearly $1\frac{1}{4}$ inches in length, and was said to have been only two months in forming. Like the growth observed by Dr. Buck, it was longitudinally striated.

Of malignant growths, **epithelioma** (Fig. 488) is the one which has been oftenest met with, cases having been reported by Gruber, Wilde, Kramer, Toynbee, Demarquay, J. Orne Green, Brunner, Burnett, Roosa, Buck, and others. More rarely sarcoma of the auricle has been observed. Malignant growths of the auricle tend to invade the auditory canal and middle ear, and death may be brought about in this way.

Treatment.—In malignant tumors of the auricle early operative interference is of course indicated, and complete removal of the auricle may be called for. Lipomata, angiomata, sebaceous cysts, etc. should be dealt with as when they occur elsewhere. Fibromata of the lobule, even when of considerable size, may be readily removed, and with little resulting deformity, by an approximately (inverted) V-shaped incision carried through the whole thickness of the lobe.

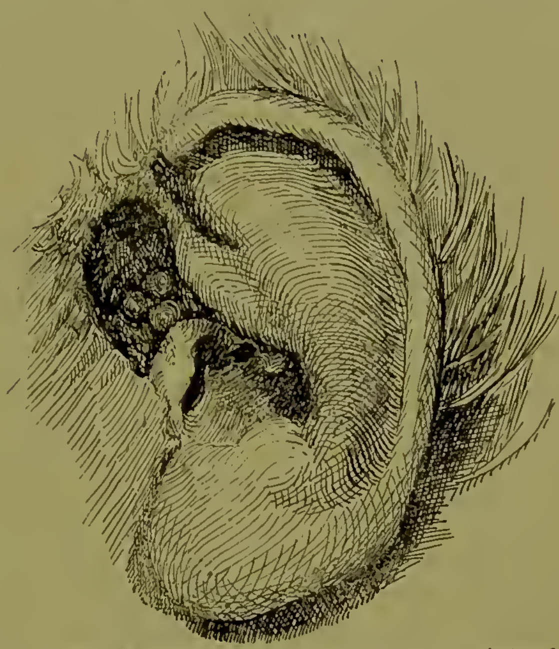

FIG. 488.—Epithelioma of auricle of 20 years' standing, with cicatricial contractions.

Wounds of the Auricle.—Lacerated and incised wounds of the auricle are occasionally met with, and exceptionally the whole auricle may be torn or even bitten off. The writer's grandfather, the late Prof. Nathan R. Smith, of Baltimore, once had a singular experience of this latter kind. A man, carrying an ear in his hand, rushed excitedly into the office, exclaiming that one of his ears had been bitten off in a fight, and that he wished it replaced. A few moments later another equally excited individual, with an auricle missing and carrying an ear in *his* hand, made his appearance, and loudly protested that the first man had taken the wrong ear and that he had brought the one which belonged to him. In the modern game of football, as in the German duel, injuries of the auricle are of such frequent occurrence that special contrivances for protecting the ear are worn.

Treatment.—When parts of the ear are cut cleanly off (as happens in the duels at the German universities), they may be replaced with every prospect that union of the divided surfaces will occur, and even when the entire auricle is cut or torn off an effort should be made to replace it, as reunion has occurred under such circumstances.[1] In closing wounds of the auricle or in reattaching severed parts stitches should be used as sparingly as possible, and should never penetrate the cartilage. Collodion, reinforced by bits of crêpe-lisse or of lint, will usually suffice to maintain the parts in apposition. Aseptic precautions are of course essential, but strong antiseptic agents should be avoided.

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[1] Von Tröltsch states that "in India, where, as is well known, the ears are sometimes cut off in war and as a punishment for crime, they are said to be sometimes replaced by transplantation from a living person" (*Diseases of the Ear*, New York, 1869, p. 51).

Cleft of the Lobule.—This condition is of frequent occurrence, and is almost always due to that relic of barbarism, the wearing of ear-rings. Occasionally it results simply from a heavy ear-ring gradually wearing its way through the lobe, but more often it is produced by the ear-ring being accidentally or intentionally torn from the ear. The writer has seen instances—and many such have been reported—where the lobe had been cleft in this way several times, and was represented by three or four teat-like projections. The deformity, even from a single cleft, is considerable, and it not infrequently happens that the aural surgeon is applied to to remedy it.

The **treatment** is by operation (see page 782).

AFFECTIONS OF THE EXTERNAL AUDITORY CANAL.

Congenital Malformations.—**Congenital atresia of the external auditory canal** has been mentioned as an occasional accompaniment of microtia and polyotia (see Fig. 481). Cases have been observed in which this defect existed without accompanying malformation of the auricle, but they are comparatively rare. The atresia may involve a part or the whole length of the canal, and may be of osseous or membranous character. A shallow depression or a somewhat deeper cul-de-sac, reaching perhaps to the point at which the bony meatus should normally begin, exists in some instances, while in others no trace of the meatus is to be found. Politzer mentions having dissected a case of atresia of the auditory canal associated with microtia in which the osseous and membranous labyrinth were perfectly formed, but in which the external meatus was represented by a fibrous cord 1 cm. long, and the tympanic cavity was entirely absent.[1] Cases of congenital narrowing of the auditory canal, and also of hour-glass contraction of the canal (Wilde), have been observed.

Even with complete bony occlusion of the auditory meatus the hearing may be fairly good if the deeper parts of the ear are normal. The writer has reported a case of complete osseous occlusion of both auditory canals (not, however, of congenital origin), in which the patient could carry on a conversation very satisfactorily if spoken to in a slightly raised tone of voice.[2] In a case of congenital occlusion of both auditory canals with microtia[3] the patient could distinguish words spoken in a low voice at a distance of six feet, even with the eyes, nose, and mouth tightly closed, as can almost every one with normal ears slightly stopped by the fingers.

Treatment.—In congenital atresia of the auditory canal it seldom happens that anything can be done to ameliorate the patient's condition, which, however, as has been indicated, is not usually as unfortunate as might be supposed. If the atresia be limited in extent, involving but a small part of the canal (which is not often the case), whether it be osseous or membranous, an effort may be made to overcome it by suitable cutting or boring instruments; but if it be more extensive, experience has shown that operative interference is of no avail, since the atresia invariably recurs. Possibly, skin-grafting by Thiersch's method might under such circumstances render the chances of

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[1] *Diseases of the Ear*, p. 698.

[2] *Trans. Amer. Otolog. Soc.*, vol. iii. p. 45.

[3] Reported by Dr. W. H. Robb in the *Amer. Journ. of Otology*, vol. iii. p. 278.

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success somewhat better. When there is simply congenital narrowing of the canal, especially if it be circumscribed, much may be accomplished in time by having the patient wear continually in the meatus an elastic plug of absorbent cotton, sponge, or some similar material.

As much rarer congenital anomalies *unduly capacious auditory canals* are met with, and also *a doubling of the canal.* Sometimes there is a second canal, terminating in a cul-de-sac, behind the true canal and having no connection with it, as in the cases observed by Velpeau and Macauln ; and again, as in Bernard's case, there may be two separate canals, which after a short course unite to form a common canal.[1]

Impacted Cerumen.—Occlusion of the auditory canal by a mass of inspissated cerumen is the affection of the external ear which most frequently demands the attention of the aurist. Usually the patient is entirely unconscious of the presence of the mass until the canal is completely occluded by it. Then the hearing, which before had not been appreciably diminished, although the ceruminous plug may have all but filled the lumen of the canal, becomes at once greatly impaired, autophony manifests itself, and very frequently tinnitus makes its appearance to add to the discomfort and alarm of the patient. Although the mass develops very slowly, many months usually elapsing before it becomes inconveniently large, the symptoms just enumerated generally manifest themselves suddenly. The usual explanation of this is that water has run into the ear in washing or bathing, or in warm weather perspiration has found its way into it and has caused the plug, which previously had nearly filled the canal, to swell up sufficiently to make the occlusion complete. Occasionally it is a fluid which the individual has intentionally dropped into the ear or some manipulation on his part of the ceruminous mass, which brings about the sudden change. Exceptionally the same symptoms may result, accompanied, perhaps, by pain, from a smaller mass of wax (which left undisturbed might not have caused inconvenience for a long time) being dislodged and pushed down upon the drumhead by the efforts of the patient to remove it. Again, when the plug is very hard and occupies the outer portion of the meatus, it may, through the movements of the jaw, exert sufficient pressure upon the canal-walls to cause pain, and perhaps inflammation, before it has become so large as to interfere with audition.

The plug varies greatly in consistency and in solubility, and frequently contains innumerable short, pale hairs (from the walls of the canal). Very often it is in part made up of pieces of exfoliated epidermis, and exceptionally it has as a nucleus some small foreign body which has found its way into the ear, or an old scab left by a former otitis. More frequently than not both ears are involved, so both should invariably be examined.

Among the rarer **symptoms** produced by the presence of impacted cerumen in the ear may be mentioned dizziness, reflex cough, perturbation of the mental faculties with inability to concentrate the mind in intellectual pursuits, disturbances of gait simulating those of locomotor ataxia (Risley), epileptiform convulsions, and, in a case reported by the writer,[2] inability to swallow, accompanied by a feeling of oppression about the heart. The added danger which results in otitis media from a pre-existent occlusion of the meatus by impacted cerumen should also not be lost sight of.

With good illumination it is usually a very easy matter to detect the presence of a ceruminous plug in the auditory canal. It is seen as a dark-brown mass filling the lumen of the canal, and with its outer surface situated usually at about the line of juncture of the osseous and membranous portions of the meatus. Touched with a probe, it may appear quite hard, or may be soft and easily indented. Generally the inner extremity of the mass reaches to, and rests upon, the tympanic membrane.

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[1] Politzer: *Diseases of the Ear*, p. 698.

[2] *Trans. Amer. Otolog. Soc.*, vol. v. p. 508.

The **etiology** of this affection has received considerable attention, and, while it cannot be claimed that it is as yet fully understood, there is a general agreement at least as to two points: in the first place, that, probably through reflex influence, the ceruminous glands are frequently abnormally active in the presence of chronic inflammatory affections of the naso-pharynx; in the second place, that under such circumstances and often perhaps independently of such conditions, there is a disturbance of the normal outgrowth of the epidermis which covers the external surface of the drumhead and lines the walls of the meatus. This in health tends to transport the cerumen from the deeper portions of the canal to its external orifice, where it falls out or is removed in the ordinary daily ablutions. That catarrh of the naso-pharynx is frequently present when there is a disposition to the formation of ceruminous plugs in the ears is a fact of daily observation, and there can be little doubt that it is an important factor in their causation. And the composition of many masses of impacted cerumen—made up, in great part, of layers of exfoliated epidermis, and sometimes enclosed in a thin pouch of epidermis which has been cast off entirely from the tympanic membrane and the walls of the meatus—would seem to show that under certain circumstances there is not only an arrest of the normal outgrowth of the epidermis, but an actual reversal in the direction of its growth, tending to a heaping up of epithelial débris in the deeper parts of the canal, as well as to an impaction of cerumen.

Treatment.—It would seem that as to the manner of dealing with so simple a condition there could be but little room for difference of opinion, still less for contention. Such, however, is far from being the case, for one very high authority tells us in his excellent treatise upon diseases of the ear that the syringe should rarely be used for the removal of cerumen, and that with the curette and the angular forceps one may accomplish in ten or fifteen minutes what cannot be done with the syringe in an hour's time; while another excellent authority tells us in his book that in four or five years he has not met with a single instance in which by means of the syringe he has failed to remove impacted cerumen from the ear in one sitting of five minutes or less, and that as to the curetting method he feels that he cannot seriously argue the question. At the risk of seeming to be contentious himself, the writer cannot refrain from saying that this last expressed sentiment meets with his fullest endorsement. But still another very high authority, whose example in most things we are glad to follow, actually commends the introduction of a strong solution of caustic potash into the ear (of course with the exercise of extreme caution) in order to saponify quickly the ceruminous mass and so to facilitate its removal. As to this procedure, it may be remarked that in kindling, and especially in rekindling a fire, petroleum is a great saver of time; but, even so, it is not the part of wisdom to commend its general use in this way.

The method of dealing with impacted cerumen which the writer has found most convenient, and which he has employed for many years, is as follows: In the great majority of cases the syringe is chiefly relied upon. When, however, the ceruminous mass proves obdurate and does not easily undergo disintegration, the angular probe or the instrument for the removal of foreign bodies represented in Fig. 490 is brought into requisition and the mass is partly broken up or separated from its attachment to the canal-wall.

After this the syringing is resumed, and usually with much better effect. Bicarbonate of soda is invariably added to the warm water (105°–110° F.) with which the syringing is done, as it unquestionably facilitates the removal of the wax and certainly does no harm to the syringe, as has been suggested. The quantity used is never accurately determined, but is approximately half an ounce to a quart. The ear is inspected from time to time to make sure that there is still cerumen in it, and that the syringing is not being kept up unnecessarily. As the mass diminishes in size and there is a likelihood that the stream of water may impinge upon the drumhead, the force with which it is thrown into the ear is lessened. The exact direction in which the stream strikes the impacted mass is not thought to be of especial moment, and no apprehension is felt that this may result in the plug being driven by the force of the water more deeply into the meatus, as some have imagined. When both ears are affected, unless the mass first attacked comes out very readily, the syringing is alternated from one ear to the other, as this saves time and appreciably diminishes the amount of syringing required. The intermittent stream of a piston syringe is employed, and is thought to be more efficacious than the continuous stream of a fountain syringe. The hard-rubber, kidney-shaped basin commonly employed by aurists has been long since discarded, because it is concave where it should be convex, and so does not fit well into the hollow beneath the ear, and because, moreover, it is so long and shallow that a very slight movement on the part of the patient is likely to cause its contents to slop over upon the clothing. Instead of this, a china bowl (one made of hard rubber or metal might be better, because less fragile) of the shape represented in Fig. 489 is used, and has been found much better adapted to the purpose, since it is free from both of the faults mentioned. It is always held by the patient, over whose shoulder a napkin is spread, rather than by an assistant, unless the patient be a young child. When inspection with the speculum and mirror shows that all of the cerumen has been removed, two or three syringefuls of plain warm water are gently thrown into the ear to wash out the previously-used soda solution. The ear is then dried with a spill of soft linen and closed with a bit of absorbent cotton, which in cold weather the patient is advised to wear until bedtime. If the plug proves to be exceptionally refractory or time be pressing, the patient is told to report the next day, and in the meantime to drop into the ear several times a little warm sweet oil, or, if it be inconvenient for him to do this, the ear is filled with a saturated solution of soda, and after perhaps a half-hour's wait the syringing is resumed. The cases in which the plug cannot be removed at one sitting are very exceptional, but the writer is compelled to admit that with the best skill he can command it is not unusual for him to spend many more than "five minutes" in accomplishing this result.

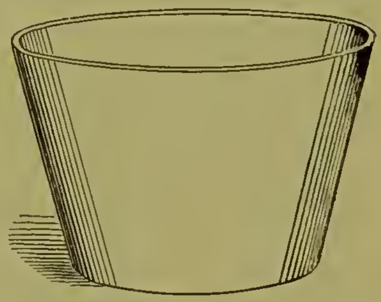

FIG. 489.—Deep cup to catch the outflow in syringing the ear.

It occasionally happens that upon inspecting the ear it can be seen that the mass of cerumen does not extend into the deeper parts of the canal. Under such circumstances, if it is found to be of its usual firmness, it is often possible with the traction instrument (Fig. 490) to draw out the whole mass at a single effort, and so to save both time and trouble. If, however, even in such a case, the cerumen proves to be of such consistency that it can be removed only bit by bit, it is better to resort to the syringe without further ado.

The writer knows of no means by which the well-recognized disposition of impacted cerumen to recur after having been removed can be overcome, except in so far as the cure or amelioration of any accompanying inflammation of the naso-pharynx tends to this result.

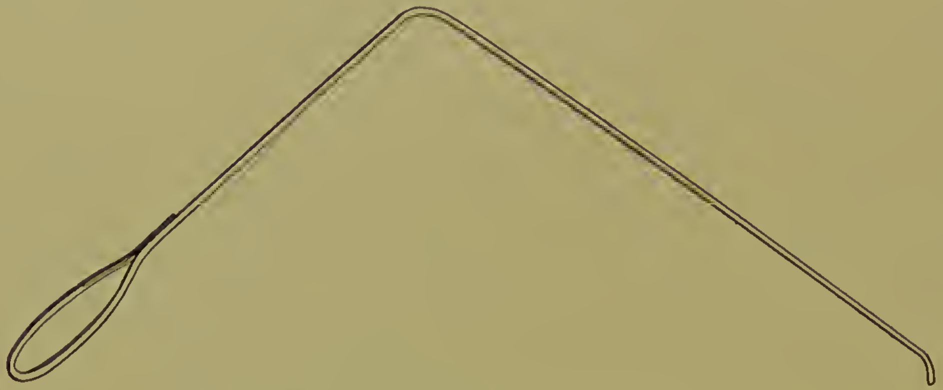

FIG. 490.—Foreign-body traction-hook made of a steel hair-pin.

Circumscribed Inflammation (*Furuncle*).—Furuncular inflammation of the external auditory canal is of very frequent occurrence. The furuncles almost always form in the outer third of the meatus, and their starting-point is in the ceruminous or sebaceous glands or in the hair-follicles which are situated in this portion of the canal. Oftener than not several furuncles occur at the same time or in quick succession, and occasionally, in the absence of proper treatment, they may recur at brief intervals for weeks. They give rise to severe pain, and to so much swelling of the membranous portion of the meatus as to occlude it completely, and so produce a transient impairment of hearing. The discharge is slight and thick, differing markedly from the more copious and thinner discharge which is usual in acute purulent inflammation of the middle ear. The swelling and sensitiveness of the meatus are commonly so great as to preclude an inspection of its deeper parts and of the tympanic membrane; but the location and appearance of the swelling, the scantiness and character of the discharge, the history of the onset of the attack, and the absence of tinnitus, and of such a degree of deafness as commonly attends acute inflammation of the middle ear, usually render a differential diagnosis from this latter affection a matter of no great difficulty.

Furuncular inflammation of the meatus is in most instances traceable to a pre-existing, perhaps very slight, dermatitis or eczema of the membranous portion of the canal. This gives rise to itching, which the individual attempts to relieve by scratching the ear with the finger-nail or with a tooth-pick, a match, a bodkin, a hair-pin, or some such instrument, and sooner or later he succeeds not only in producing an abrasion of the canal-wall, but in implanting upon this denuded surface, which in all probability involves the orifices of several of the ceruminous or sebaceous glands, a pyogenic organism (usually the staphylococcus aureus or albus), the subsequent development of which brings on the furunculosis. In other instances the furuncular inflammation is secondary to otitis media purulenta—a localized infection, from the entrance of the micrococci into the hair-follicles or into the ceruminous or sebaceous glands, resulting from the walls of the canal being constantly bathed in the pus which flows from the middle ear. A depressed state of the general health is also frequently an important factor in the etiology of furunculosis of the external ear as it is in furunculosis occurring in other regions.

Exceptionally, small abscesses are met with in the deeper portion of the meatus. These usually run a more protracted course, being often dependent upon caries of the underlying bone or upon tympanic or mastoid disease.

Treatment.—If seen in its incipiency, furuncular inflammation of the auditory meatus can occasionally be aborted by the application to the walls of the canal of an ointment of yellow oxid of mercury and vaselin (gr. j–ij to ʒj) and the administration of a brisk calomel cathartic; and, it may be added, in the occasional application of this same ointment we have a prophylactic measure of great value, for the chronic dermatitis, which, as has been said, is so often the precursor of furunculosis, may by this means almost always be cured or kept in abeyance, and thus the disposition to acute outbreaks be removed.

When the furuncle is more fully developed, so favorable a result is not to be anticipated, but the yellow-oxid ointment is still useful in lessening the likelihood of the inflammation invading other follicles. For the relief of the severe pain, the head (in lying down) should be kept as high as practicable, dry or moist heat (a Japanese "stove" or a pad of gauze wrung out in hot water, freely sprinkled with laudanum and covered with a piece of rubber protective or oiled silk) should be applied to the ear, and six or eight drops of a solution of atropia and cocain in almond oil[1] (atrop. alk. gr. j, cocain alk. gr. ij, ol. amyg. dulc. ʒij) should be dropped into the canal (and retained by a pledget of cotton) three or four times in twenty-four hours, or the "baume tranquille" of the French Codex may be similarly employed. The application of a 10 to 20 per cent. solution of menthol in albolene or olive oil is also recommended. Should these measures fail to relieve the pain, as, it must be admitted, not infrequently happens, morphin may be administered hypodermically or by the mouth.

The writer is inclined to agree with those (Wilde, Buck, and others) who think that a very early incision of the furuncle is uncalled for, and may do more harm than good. When, however, it is evident that pus has formed, its escape should be facilitated by an incision, which may be conveniently made with the knife represented in Fig. 491, which some years since the writer contrived for this purpose. The local abstraction of blood hardly seems to be called for, although it is claimed for it that, if employed at the outset, it often proves of much value. After the furuncles have opened or been incised, douching or gently syringing the ear with a saturated solution of boric acid is a useful measure. The state of the bowels and the general condition of the health should be looked to, and tonics or laxatives should be administered when they seem to be indicated.

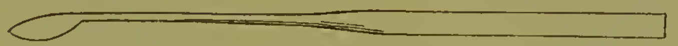

FIG. 491.—Writer's knife for incising furuncles of the external auditory canal (to be used with the angular handle shown in Fig. 523).

Diffuse Inflammation.—Diffuse inflammation of the external auditory canal occurs as an acute and as a chronic affection. It differs from furuncular inflammation in that it tends to involve the whole extent of the auditory canal, the osseous as well as the membranous portion. The pain which usually is present only in acute cases is, as a rule, not so severe, and the swelling, especially at the orifice of the meatus, not so marked, as in furunculosis. The discharge is slight and generally serous or sero-purulent in character. In the chronic cases especially, itching is a prominent symptom. The dermal layer of the tympanic membrane is frequently involved in the inflammatory process, and, like the neighboring walls of the meatus, may be markedly hyperemic. There is also a disposition to exfoliation of the epidermis from the drumhead as well as from the canal-walls.

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[1] This solution has been prepared, at the suggestion of the writer, by Messrs. Hynson & Westcott, of Baltimore, as a substitute for the aqueous solutions of the salts of cocain and atropia. It has been found especially valuable in the treatment of acute otitis media.

Frequently the disease is essentially an eczema of the external ear, and the auricle, as well as the auditory canal, may be involved in the inflammatory process. It is often present in chronic otorrhea, being excited by the continual flow of pus through the meatus. In other cases it is of traumatic origin, arising perhaps from the entrance of some irritant substance or foreign body into the ear; and in still others it is due to the presence in the auditory canal of a fungous growth, usually the aspergillus nigricans, and less often the aspergillus glaucus or the aspergillus flavescens. For this variety of inflammation of the external ear Virchow has suggested the name *otomycosis*.

A variety of diffuse otitis externa which deserves especial mention, and the etiology of which is not very well understood, is that which is denominated *desquamative inflammation of the auditory canal*, and which leads to the condition known as *keratosis obturans* or *cholesteatoma*. Primarily, this is a diffuse dermatitis characterized by an excessive proliferation and desquamation of epithelium; but at a later stage the periosteum and underlying bone are not infrequently involved,[1] and areas of caries and necrosis, sometimes accompanied by the development of polypi, may occur; while in some instances marked absorption of the bony walls of the meatus takes place, resulting in a great increase of its caliber. Eventually, the auditory canal becomes completely occluded by the exfoliated epithelium, which forms into a tough, laminated plug containing between its layers an admixture of inspissated cerumen. For a time this may give rise to no inconvenience other than deafness, probably accompanied by tinnitus; but sooner or later, through the invasion of bacteria (which seems to be Nature's method of ridding the economy of such an incubus), an acute outbreak of inflammation occurs, accompanied by pain, suppuration, and partial disintegration of the laminated mass. It is at this time that medical advice, if it has not previously been obtained, is usually sought.

Treatment.—As may be inferred, the treatment of diffuse inflammation of the auditory canal will necessarily vary with the origin and character of the attack. For the relief of pain the anodyne applications which have been described in treating of furuncular inflammation, and especially the solution of the alkaloids of cocain and atropin in the oil of sweet almonds, will be found useful. In otomycosis the intruding fungus must be gotten rid of as soon as possible—in the first place, mechanically, by means of the syringe, forceps, and traction-hook; and, in the second place, by the insufflation of the powder containing equal parts of oxid of zinc and boric acid which has already been spoken of, and which was recommended for this purpose by the writer many years since.[2] The efficacy of this remedy, which depends upon the drying effect of the oxid of zinc as well as upon the proven specific action of boric acid in preventing the growth of aspergillus and other related fungi, is so marked that, in the experience of the writer, a second application is only exceptionally required to completely destroy the varieties of aspergillus which are usually encountered in the ear. It has, moreover, the great additional advantage of being one of the best possible agents for the relief of the inflammation of the auditory canal excited by the presence of the parasite, in this respect certainly being far better than alcohol, which has been widely commended for the destruction of aural fungi. With the eradication of the aspergillus the inflammation usually subsides promptly; and, as a rule, no other treatment than the insufflation of the zinc and boric acid, which may require to be repeated once or twice, is called for.

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[1] Perhaps the primary lesion [Ed.]. [2] *Amer. Journ. of Otology*, vol. iii. p. 119, April, 1881.

In desquamative inflammation the removal of the mass of exfoliated epithelium, which sometimes is a difficult task, requiring several sittings, is of course the first thing to be accomplished. This can best be effected by the syringe, aided by the forceps, traction-instrument, and probe. The removal of the plug should be followed by the insufflation of boric acid and oxid of zinc, which the writer has found especially useful in these cases. A powder containing equal parts of aristol and boric acid has also been found of service. In the uncomplicated forms of diffuse inflammation of the auditory canal—which, as has been said, are frequently eczematous in character—these same applications are indicated if a drying effect is desired; while in other cases the yellow-oxid-of-mercury and vaselin ointment, previously mentioned, is often of great value; and so also is an ointment composed of oxid of zinc, boric acid, and vaselin, to which a small quantity of balsam of Peru may at times be added. (Zinci oxide gr. xxx–lx, acid. boric. ʒj, vaselin ℥j). Strong solutions of nitrate of silver (ʒj–iij to ℥j) are highly commended by Buck and others. Tonics, laxatives, and other constitutional remedies, such as the salts of lithia, arsenic, etc., may often be prescribed with advantage. Polypi, if present, should be removed with the forceps or snare (they are usually quite small, but may be multiple), and any areas of carious bone should be carefully curetted, or, better still, perhaps, if limited in extent, should be touched with muriatic acid diluted with two or three parts of water, which seems to do good not only by its stimulant action, but by its solvent effect upon the necrosed bone.

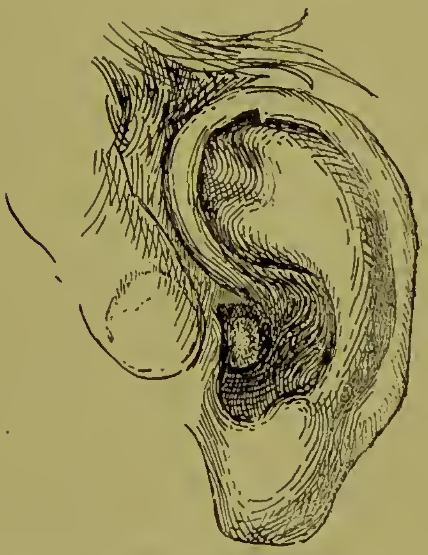

FIG. 492.—Myxomatous polyp filling the canal.

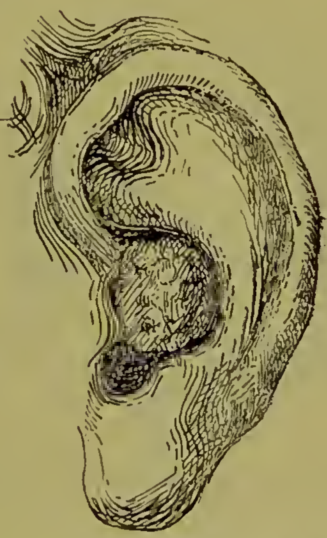

FIG. 493.—Large polypoid mass growing out from depths of the canal and filling the concha.

Polypi.—In most instances where a polypus is found occupying the external auditory canal it has its origin in the tympanic cavity, and grows from there (the drumhead being partially or completely destroyed) into the meatus. Exceptionally, however, the polypi which form in the course of chronic otorrhea spring from the walls of the canal, usually in the neighborhood of the membrana tympani. They also are occasionally met with in the absence of perforation of the drumhead, as after injuries of the meatus, caries of its walls, furuncular inflammation, and, as has just been indicated, in the course of desquamative otitis externa. Poulticing is at times responsible.

Their **treatment** consists in early removal (with forceps if they are small, or with the snare if they are larger and their point of attachment cannot certainly be made out), the application of chromic acid to the pedicle, and the insufflation of boric acid by itself or in combination with aristol or oxid of zinc. Properly carried out, these measures render a recurrence of the polypus very unlikely.

Exostosis and Hyperostosis.—The term exostosis is applied to those bony growths upon the walls of the external auditory canal which are circumscribed and fairly well defined in contour (Fig. 494); while by hyperostosis is meant that condition in which the caliber of the bony meatus is gradually encroached upon (see Fig. 464), probably throughout a considerable part of its length, by a diffuse growth of bone, which is usually the result of a chronic periostitis secondary to long-standing otorrhea. In extreme cases of hyperostosis a complete bony occlusion of the canal may result, which, from its appearance only, cannot always be distinguished from congenital atresia. A case of this character observed by the writer has already been referred to in treating of congenital anomalies of the external auditory canal. The growths denominated exostoses are met with in all parts of the osseous canal, vary greatly in shape, being usually mound-like, with a broad base, but occasionally distinctly pedunculated; may occur singly or in groups, and differ markedly in structure, being sometimes of ivory-like hardness and at other times composed of soft cancellous tissue. They may be present in the auditory canal for years without their existence being known, for they are usually of very slow growth and quite painless. Their presence is frequently revealed by some intercurrent aural affection, such as acute otitis media or an accumulation of cerumen, which affections, as may be readily understood, they may greatly complicate. Gout, rheumatism, and syphilis have been regarded as having to do with their causation, but this has not been clearly demonstrated. That there is a racial predisposition to growths of this character is certainly true. They are said to be more frequent among the inhabitants of England than among our own people, are of very common occurrence among the natives of the Hawaiian islands, and have been observed very often in the skulls of the Mound-builders.

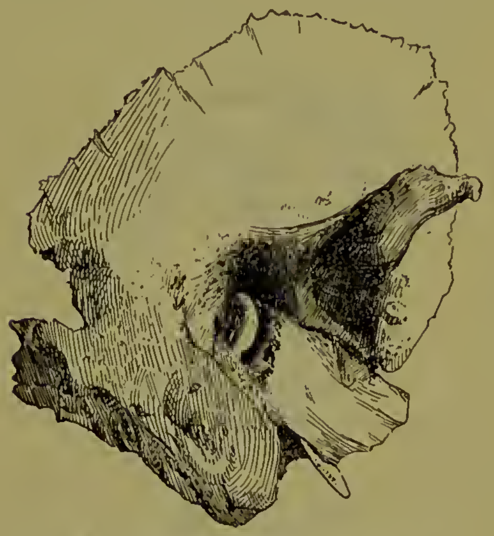

FIG. 494.—Exostosis arising from the back wall of the canal.

Treatment.—When occlusion of the meatus is threatened from a diffuse hyperostosis every effort should be made to cure the otorrhea which usually coexists, as this of itself may arrest the progress of the affection. It will also permit the continuous wearing of an elastic plug in the canal, which in time may be expected to effect something in the way of dilatation. The plug should not be harsh in its action, however, or it may do more harm than good. Fine sponge and absorbent cotton have already been mentioned as being useful for this purpose. When complete bony atresia of the canal exists, operative interference is not indicated unless there is good reason to believe that the septum is quite thin, for under other circumstances it is almost sure to prove of no avail.

As to the treatment of the circumscribed osteomata, non-interference is generally advised, unless there be some especial indication for operation; as, for example, when the enlargement of the growth is interfering with audition or when some intercurrent trouble, such as otitis media suppurativa, complicates the situation. When the exostosis is pedunculated and is so situated that its removal is not a difficult matter, the writer thinks that it is judicious to get rid of it without waiting for possible future complications. His experience in the removal of such growths is limited, but, so far as it warrants deductions, is distinctly favorable to the use of the gouge and mallet rather than the dental lathe, which has been recommended for this purpose.

False Membranes.—An occlusion of the auditory canal of much less formidable character than that which may result from hyperostosis is occasionally met with. The occluding membrane is sometimes composed simply of the epidermal layer of the drumhead, which has been cast off entire, and of course is without vitality. When such a membrane is located near the inner extremity of the meatus, it is not always easy to distinguish it from the true tympanic membrane altered by disease. It interferes in some measure with the hearing, and should be broken through with a probe and removed with the traction-hook or forceps. In other cases the membrane is of quite a different character, being supplied with blood-vessels and possessing a low vitality. Such septa, as Buck has pointed out, are usually the result of granulation-tissue springing from opposite points of the walls of the canal and uniting in time to form a continuous membrane.[1]

Treatment.—As septa of this character interfere materially with hearing, their removal is indicated. This may be effected by any suitably shaped knife, and, as they show at times a disposition to recur, the subsequent application of chromic acid or other caustic agent to the marginal remains of the membrane may be called for. In the writer's case, to which reference has been made, the removal of the membrane and the subsequent wearing of a vaselin and cotton artificial drum resulted in very marked improvement in hearing (see page 784).

New growths, having their origin in the external auditory canal, apart from osteomata and polypi, are extremely rare. Sebaceous cysts upon the walls of the meatus are met with occasionally; chondromata have been observed by Launay and Politzer; and cases of cylindroma, pedunculated papilloma, and of epithelioma and sarcoma have been reported.

The indications for **treatment** are simply those which apply to similar tumors located elsewhere.

Syphilis does not often invade the external auditory meatus, but one case at least of primary infection at this point has been observed. Condylomata and syphilitic ulcers are more frequently encountered. The diagnosis is facilitated by the presence of syphilitic lesions in other parts of the body.

Treatment.—Knapp recommends dusting condylomata with calomel, and subsequently painting them with a 1 per cent. solution of nitrate of silver. Politzer touches them with nitrate of silver or a concentrated solution of chromic acid, and afterwards applies a 1 : 30 solution of corrosive sublimate. For syphilitic ulcers he uses tincture of iodin, painting it upon the ulcer several times. He also mentions a case in which healing was brought about by keeping a plug of mercurial plaster in the meatus. Calomel and the yellow oxid of mercury suggest themselves as remedies likely to prove useful.

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[1] For a report of several interesting cases of this character observed by Dr. Buck see his *Manual of Diseases of the Ear*, p. 110 *et seq.*, and for an account of a similar case met with by the writer see *Trans. Amer. Otol. Soc.*, vol. iv. p. 541, 1890.

Wounds involving only the external auditory canal are rare. Buck speaks of the tendency to persistent hemorrhage which characterizes such wounds, and gives as an explanation that the blood-vessels of the cartilaginous framework of the canal are capable of contracting and retracting to but a limited extent. Slight abrasions of the walls of the meatus from efforts to remove cerumen or to relieve itching are common, and are of importance only because, as has been stated, they so often lead to furuncular inflammation. Fractures of the base of the skull not infrequently involve the walls of the bony meatus.

The indications for **treatment** are to free the canal from blood and any extraneous substances which may be present by syringing with a warm antiseptic solution (boric acid), and then, by the insufflation of boric acid or boric acid and aristol, and closing the meatus with a cotton plug, to keep the parts as nearly aseptic as possible.

Foreign Bodies.—Although the position and conformation of the auditory canal do not favor the entrance of foreign bodies, they not infrequently find their way into the ear. Children have a habit of thrusting such things as beads, beans, cherry-stones and the like into their own ears or into the ears of their playmates, while inanimate objects of a different character, such as grains of wheat, small pebbles, etc., sometimes find accidental entrance into auditory canals of adults. Living insects also occasionally invade the ear—sometimes by accident and sometimes by design, being perhaps attracted by the odor of a purulent discharge. Many cases, for example, have been reported in which dead flies have been found in suppurating ears, and others in which the living larvæ of the fly were present.

The common belie is that the presence of a foreign body in the ear, without reference to its character or its mode of lodgement, is necessarily a serious matter. It is hardly necessary to say that this belief is groundless. Usually, unless the object be tightly impacted in the canal, or be pressing upon the drumhead, or be of such shape or nature as to cause exceptional irritation, its presence in the ear is scarcely appreciated. On the other hand, if the substance which has entered the ear be of an irritant or caustic nature, or be jagged in shape and so wedged in the canal that the movements of the jaw cause it to wound the walls of the meatus, it may give rise to severe pain and quickly produce inflammatory reaction. The entrance of living insects into the ear usually causes great discomfort, and sometimes intolerable agony, for the contact of their wings and feet with the tympanic membrane is not only very painful, but produces noises which are almost as unbearable. Maggots when they enter the ear cause severe pain, and are difficult to remove, because, as Blake has pointed out, they attach themselves to the walls of the canal by a peculiar hook-like apparatus which they possess, and feed upon the inflamed integument. The writer once removed from the ear a living tick which had attached itself to the wall of the meatus. It had entered the ear about two weeks previously, and for some days a black, granular substance (its excrement) had been coming from the canal, while a sound "like broiling" had been heard from time to time, and pain was beginning to make itself felt. He has also removed flies, maggots, cockroaches, and "bugs" of various kinds and sizes. Stiff hairs from the head or beard occasionally find their way into the ear, and if so placed as to press upon the drumhead, may cause much discomfort.

It should be mentioned that the presence of a foreign body in the ear may excite marked reflex phenomena. Cases have been reported, for example, in which cough, vomiting, excessive salivary secretion, hemicrania, facial paralysis, and epileptiform convulsions have been produced in this way (Poulet).

Treatment.—The question of how best to deal with a foreign body lodged in the ear depends upon a variety of circumstances, and especially upon the skill and experience of the operator. Doubtless it is best not to allow any foreign body to remain indefinitely in the auditory canal; but, as in most instances it is not at all likely to produce immediate ill consequences, hurried and unskilful attempts at removal without proper instrumental aid, whether undertaken by layman or physician, are to be discouraged. The need for interference is seldom so urgent that time cannot be taken to obtain expert assistance, and it should be borne in mind that the cases which prove to be serious and which tax the ability of the aural specialist are almost invariably those which have previously been subjected to the well-meant but injudicious efforts of the unskilful.

At the outset it is of the utmost importance to make sure that there really is a foreign body in the ear, for it not infrequently happens that misapprehension exists upon this point; and patients are brought to the physician for the removal of a foreign body which has no existence except in their imagination or in the imagination of those who have them in charge. If it be lodged near the orifice of the meatus, it can scarcely escape detection at a glance, but if it be near the tympanic membrane, an ear-mirror and speculum will usually be needed for its discovery; and, indeed, in some ears (in which the upward bend of the floor of the meatus is exceptionally pronounced) it may be impossible, if the foreign body be a small one and be lying in the angle at the lower margin of the drumhead, to bring it into view even with the best means at command for aural inspection. It ought not to be necessary to utter a word of warning against mistaking the bright surface of the tympanic membrane itself for a foreign body; but, as mistakes of this kind have occurred, and at the cost of serious damage to the hearing apparatus, such a warning is perhaps not altogether superfluous.

In unskilled hands or with a very unruly patient the syringe is the safest instrument to employ for the removal of foreign bodies from the ear, and it is one which usually will be found to accomplish the end in view. If, however, the foreign body be tightly wedged in the canal, from having swollen, as beans, peas, and such like objects are likely to do after entering the ear, from inflammatory swelling of the canal itself, or from awkward efforts to remove it, the syringe is not likely to prove effectual. Whether, under such circumstances, the physician unfamiliar with operative procedures upon the ear should desist from further instrumental interference and refer the case to an aural surgeon, must of course depend in a great measure upon whether such skilled assistance can be readily obtained or not. To introduce any form of instrument into the ear and grope blindly about in the hope of extracting a foreign body is a most reprehensible procedure, and one so much more likely to do harm than good that it can hardly be justified under any circumstances. Such awkward manipulations have been known to result not only in loss of hearing, but even in loss of life. Without exception, when any instrument is introduced into the ear for the removal of a foreign body, the auditory canal should be illuminated with the ear-mirror (artificial or diffuse daylight being used as may be preferred), and the foreign body itself and every movement of the instrument should be kept constantly in view.

For the removal of foreign bodies which are not spherical in shape and do not fill the lumen of the canal—such as insects, bits of wire, chips of wood, and the like—the angular forceps are extremely useful; but when a glass bead, a pea or bean, or other roundish body is impacted in the meatus, they are worse than useless, for they cannot be opened wide enough to grasp the object, and every unsuccessful attempt to accomplish this only serves to drive it more deeply into the ear. For the extraction of such bodies—and they are among those most frequently encountered—the writer has found a traction-hook similar to Fig. 490, but stronger, extremely valuable. The body can scarcely be so tightly wedged in the ear as to prevent the bent tip of this instrument (which is serrated upon its under surface to make it catch the better) being at some point insinuated between it and the walls of the canal; and when this is accomplished and the hooked extremity, now beyond the body, is turned so as to catch hold of it, there can be little excuse, unless one's efforts are balked by unruly behavior on the part of the patient, for failing to rid the ear of the intruding body, either by simple traction or by rolling it over and over.

There is nothing which so facilitates manipulations of this character as co-operation on the part of the patient, and nothing which so complicates them as the lack of it. Ordinarily, with a ruly patient, the extraction of a foreign body from the ear is not a painful procedure; but if the walls of the canal have been lacerated by previous rough usage or have become swollen and inflamed from the presence of the intruding body, the infliction of some pain can hardly be avoided. Under such circumstances the previous instillation of a strong solution (10 per cent.) of cocain diminishes the pain in some measure. In unruly children the administration of a general anesthetic is not infrequently called for. In the absence of such an instrument as above indicated, or the loop of a snare, an excellent substitute may be improvised from a steel hair-pin of good quality. The writer is rather fond of making traction-hooks in this way to suit his fancy, and the improvised instrument shown has done most excellent service.

When an insect or other animate object has entered the ear, since its movements are likely to cause much suffering, it is important that an end should be put to its life as quickly as possible. Ordinarily the most efficacious and convenient way of accomplishing this is by pouring into the ear olive oil or any other bland oil that may be at hand. Maggots, however, live for a long time in oil, which, therefore, is not useful when they are present. Dr. Roosa has recommended for their destruction the vapor of chloroform and also Labarraque's solution. If a caustic substance has entered the auditory canal, the ear should be syringed with a neutralizing solution—in the case of an alkaline caustic, vinegar, which is usually at hand, diluted with warm water may be used, and in the case of an acid, the bicarbonate of soda.

Probably, in dealing with foreign bodies in the auditory canal, the writer has had more than his share of good luck; for he does not recall an instance in which he has failed to remove a foreign body from the ear at one sitting—some one of the methods which have been described having been always relied upon. Hence he has felt no temptation to resort to the rather radical procedure (see page 786) of displacing the auricle and cartilaginous meatus, which has been recommended to facilitate the extraction of foreign bodies from the ear. Some years since, in writing of this operation, he stated that he could "scarcely conceive of a case which would warrant recourse to such an expedient;"[1] and later experience has not served to change materially the opinion then expressed.

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[1] Buck's *Reference Handbook of the Medical Sciences*, vol. i. p. 425.

INJURIES AND DISEASES OF THE DRUMHEAD.

By H. V. WÜRDEMANN, M. D.,

OF MILWAUKEE, WIS.

Traumatic Lesions of the Drumhead.—Considering the delicacy of the tympanic membrane and the relative frequency of accidents to the head it is seldom liable to injury, thanks to its protected situation within the skull at the bottom of the external auditory canal.

Hemorrhage.—Sneezing or coughing, especially in pertussis or in asthmatics with arterio-sclerosis, may produce circumscribed hemorrhages in the membrane (Plate 11, Fig. 2). Patients experience transient, slight pain, and examination reveals dark red or brown, circumscribed spots, which cannot be wiped away. Such may occur after Politzer's method of inflation, catheterization, after sudden condensation or rarefaction of the air in the external meatus, and from direct injury without perforation of the membrane. *Hyperemia* and hemorrhage occur in the course of myringitis and otitis media from acute infectious disease[1] (due to rupture of the small blood-vessels causing true hemorrhage in the dermal layer), in dense or rarefied atmospheres from the same cause, as in the case of miners or divers, and mountain-climbers or aëronauts, or in persons who have not been accustomed to sudden changes of atmospheric pressure. It is also an occasional accompaniment of scorbutus, typhus, dengue, bubonic plague, and other infectious diseases.[2] Vicarious hemorrhage has also been reported.

Direct injuries to the membrane are oftenest observed after unskilful attempts to remove foreign bodies by patients, their friends or physicians (Plate 11, Figs. 3, 4). Slight injuries are sometimes self-inflicted by persons who are accustomed to remove wax or scratch the canal with ear-spoons, toothpicks, etc. (Plate 11, Fig. 5), or who have acquired the habit of scratching their ears[3] with pencils or pen-holders while deep in thought (Plate 11, Fig. 6). Ill-considered attempts at removal of foreign bodies and of inspissated cerumen (Plate 11, Fig. 7) by forceps, scoops, or syringes with long nozzles may cause dangerous injuries. In cases of myringitis or after gentle removal of impacted cerumen, the simple application of a cotton pledget for drying the ear may rub away the epidermal layer. If aseptic, such slight injuries heal within a few hours. The forcible entrance of water or foreign bodies, such as insects, twigs, etc., into the canal gives rise to superficial or deep injury. The instillation of strong medicinal solutions, as caustics, the use of very hot or very cold solutions, as hot glycerin (Plate 11, Fig. 8), olive oil, etc., may cause lesion of the canal and external layer. A means of torture in ancient times was pouring of hot wax or lead into the ears, which produced effects varying from superficial injury to death; and the membrane may now be injured in metal-workers by the splashing of molten metal. Direct injury and even perforation from the tympanic side has been produced by the Eustachian bougie (Urbantschitsch). Direct injuries, such as punctures and abrasions, are usually found in the anterior half, as pointed objects slide off the more obliquely placed posterior portion of the membrane (Politzer).

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[1] Haug: *Krankheiten des Ohres in ihren Beziehung zu den Allgemeinen Erkrankungen*, 1893.

[2] Richardson: "Hemorrhage from External Auditory Canal," *Annals of Ophth. and Otol.*, July, 1896.

[3] Politzer: *Lehrbuch der Ohrenheilkunde*, 1888.

Rupture of the drumhead is frequently caused by slapping the face and ears of children for punishment by teachers or parents, thus producing sudden compression of air in the external meatus. It occasionally occurs in sparring (Plate 11, Fig. 9), and is common from injuries caused by explosions of gunpowder, dynamite, fire-arms, and boilers. Improper inflation methods, such as the use of compressed-air apparatus at high pressure, the catheter or Politzer bag by unskilled hands or in improper cases, may produce rupture of the drumhead. Spontaneous perforation frequently occurs in acute catarrhal or suppurative otitis media. Fracture of the base of the skull is generally attended by bleeding from the ear and rupture of the membrane (Plate 11, Figs. 10, 11). A diseased, inflamed, or weakened drumhead is more liable to injury than if normal, especially where there has been misplacement or thinning of its structure. The normal drumhead is resilient, and cannot be ruptured under a pressure of 4 or 5 atmospheres (Gruber). The flaccid membrane is seldom broken, as it is less tense and plays an important part in preventing ruptures.[1] The so-called Rivinian foramen does not commonly exist in the normal subject, and is not the safety-valve which has been supposed. The situation of the rupture is indifferently placed in the anterior or posterior halves of the tense membrane, usually near the handle of the malleus. It may be single or double, depending upon the character of the injury. Both large and small perforations may follow slight blows upon the head. The handle of the malleus (Plate 11, Fig. 11) is rarely fractured, although cases have been reported, as well as of dislocation[2] (Plate 11, Fig. 3).

Symptoms.—At the time of the injury there is sharp pain, which may last for several hours, and is usually accompanied by dizziness and sometimes by nausea. If the upper part of the drumhead be injured, disturbance of the sense of taste may occur, as where the chorda tympani nerve is divided in operations, but recovers after several weeks. If seen shortly after lacerating injuries, there will be found fresh blood or clots in large or small amount in the meatus or on the drumhead, or, if the perforation be large, in the middle ear. The edges of the wound are at first irregular and covered with fresh blood. Twenty-four hours after the injury, however, there is usually hyperemia, especially of the edges of the perforation, which appear more even. If the ear has been tampered with or not occluded from the atmosphere, infection followed by acute suppuration and sometimes persistent perforation may occur. Simple puncture by clean instruments, such as the paracentesis knife, in ears that are aseptic and not inflamed, will frequently in a few hours heal and close without cicatrix.

The **diagnosis** of traumatic injury, perforation, or rupture may generally be made by its appearance and the history. If seen shortly after the accident, the edges of a rupture are found gaping, so that the yellowish-red lining membrane of the tympanic cavity may be seen. Fresh bleeding is of course diagnostic. A differential symptom is the character of the sound on inflation, as in traumatic perforation the whistle is said to be deep and harsh, while in pathologic perforation it is sharp and shrill (Politzer). It is of forensic im-

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[1] Bacon: Burnett's *System.*, i. p. 256.

[2] Theobald: *Trans. Amer. Otol. Soc.*, 1891.

DESCRIPTION OF PLATE 11.

FIG. 1.—Normal tympanic membrane.

FIG. 2.—Hemorrhage into the dermal layer after brisk inflation in a man aged thirty with chronic aural catarrh and adhesions of membrane to promontory. Sketch made two days afterward. The clots did not become entirely absorbed, and pigment could be seen for two years.

FIG. 3.—Destruction of the drumhead and dislocation of malleus into canal from impaction of pebble in middle ear, due to attempts at removal with wire loop, which was broken in the operation, in a child aged three. Removal by snare, and healing under antiseptic dressing.

FIG. 4.—Large rupture of drumhead and impaction of glass bead in tympanum, caused by attempts at its removal by members of the family and physicians, in a child aged four. Removed by snare and rat-tooth forceps. Suppurative otitis with permanent perforation and partial deafness ensued.

FIG. 5.—Self-inflicted wound of dermal layer from hair-pin used for removing "artificial drumheads," in a woman aged forty-six, subject of chronic catarrhal otitis. Healing in two days under antiseptic dressing.

FIG. 6.—Penetrating wound of drumhead from slate pencil in a girl aged eight. Healing in one week.

FIG. 7.—Abrasion of dermal layer and canal from forceps and ear-scoop used by a physician in attempted removal of impacted cerumen. Healing in three days.

FIG. 8.—Acute myringitis from instillation of hot glycerin in a man aged forty-seven with chronic aural catarrh and vertigo. The usual appearances were restored in five days.

FIG. 9.—Double rupture, seen one hour after the accident, in a man aged twenty-six who had received a box on the ear during a sparring contest. Healing in two weeks.

FIG. 10.—Rupture of drumhead in a man aged twenty-seven who had fracture of the base of the skull following fall on back of head. Total and persistent deafness with vertigo and tinnitus. Slight suppuration stopped in four days, but perforation persisted. Sketched one week after accident.

FIG. 11.—Fracture of the malleus and canal in a man who committed suicide by being run over by a locomotive, sustaining fracture of the skull, and death twenty-four hours afterward. (Adapted from Kirchner.)

FIG. 12.—Acute myringitis in stage of maceration, in a woman aged twenty-three, caused by aspergillus growth in the canal after lake-bathing.

FIG. 13.—Acute myringitis bullosa in a boy aged thirteen, due to pond-bathing. Healing in one week after puncture of vesicles and antiseptic treatment.

FIG. 14.—Acute myringitis with sanguineous abscess or hematoma in a man aged thirty. Paracentesis with healing in several days.

FIG. 15.—Acute myringitis with multiple abscesses under the dermal layer in a man aged twenty-six. Healing in about one week after puncture of the abscesses, without implication of the middle ear.

FIG. 16.—Chronic myringitis granulosa in a boy aged fifteen who had discharge from the ear for several years. Healing under cauterization of the granulations and antiseptic treatment.

FIG. 17.—Chalk-formation in chronic suppuration of twenty years' standing in a man aged forty-seven. Small perforation in lower anterior quadrant.

FIG. 18.—Chalk-formation in chronic aural catarrh of long standing in a woman aged thirty-five. The membrane is greatly retracted, thickened, and nearly immovable, and with the ossicles is sclerosed.

FIG. 19.—Chalk-formation in an otherwise normal membrane in a physician aged thirty-five who had full hearing and no other evidence of ear disease.

FIG. 20.—Sclerosis of the middle ear with thickening and retraction of the membrana vibrans in a woman aged forty-eight who had chronic aural catarrh of long standing.

FIG. 21.—Atrophy of posterior segment of the membrana vibrans in a man aged thirty-five who had normal hearing and no history of ear disease. The membrane is translucent and retracted, showing the incudo-stapedial joint.

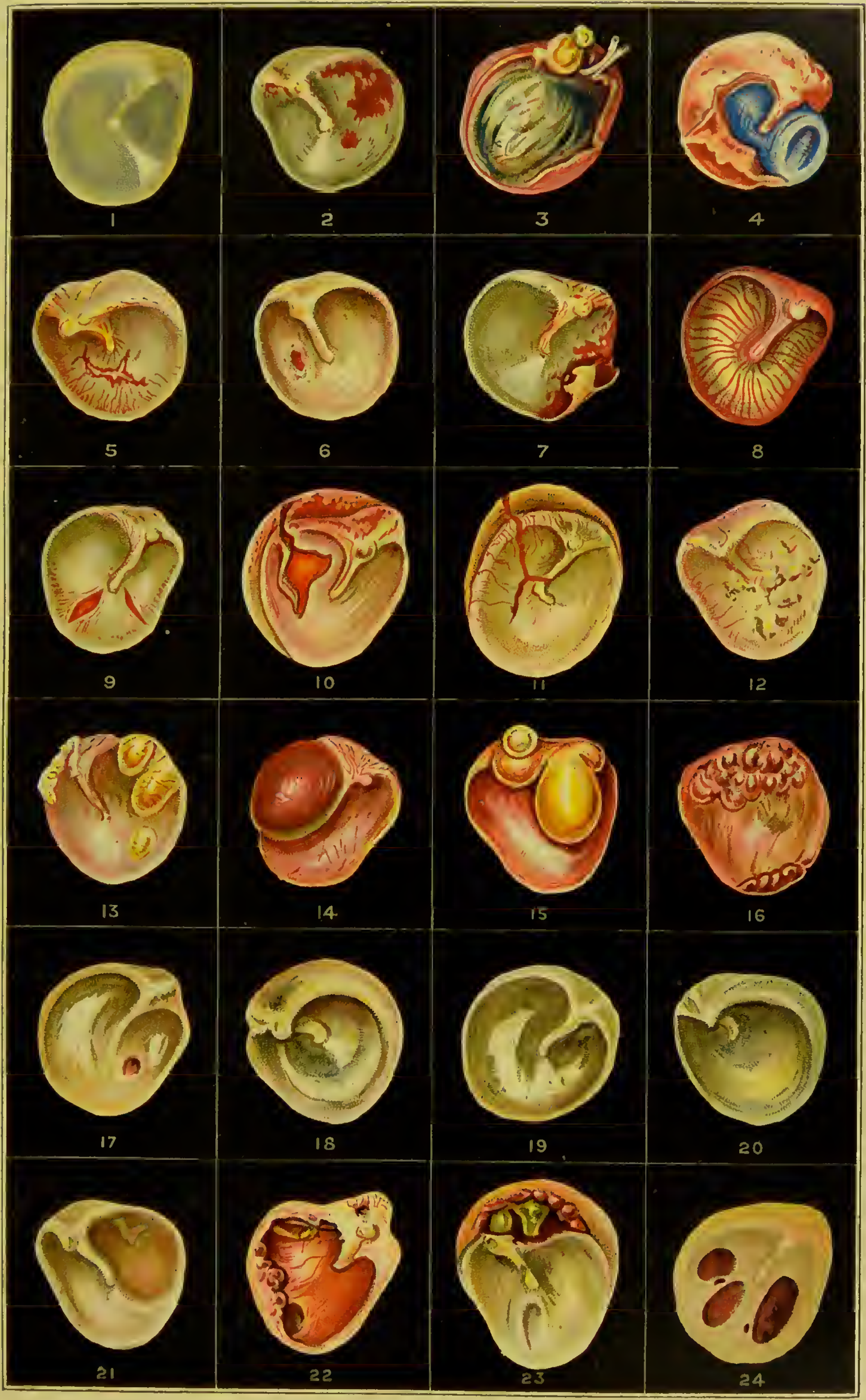
FIG. 22.—Large perforation of the membrana vibrans and small perforation of the membrana flaccida of the right ear in a man aged thirty-four who had scarlatinal suppurative otitis since infancy. The malleus-handle is shortened by necrosis; the stapes and incus with the chorda tympani nerve show through the upper part of the perforation; the promontory and fenestra rotundum with the engorged and swollen mucous membrane of the tympanum are likewise visible; exuberant granulations show on the posterior rim of the perforation.

FIG. 23.—Extensive destruction of membrana flaccida with cicatricial changes in membrana vibrans of left ear of same person (Fig. 22). The necrosed incus, head of malleus, and granulations of the tympanic attic and osseous ring show through the perforation; the malleus-handle is shortened through previous caries.

FIG. 24.—Three large and two small perforations occurring in the pallid right drumhead of a man of thirty-five with tuberculous laryngitis.

LEEDS & WEST RIDING
MEDICO-CHIRURGICAL SOCIETY

PLATE II.



Injuries and diseases of the drumhead.

portance to determine whether or not a perforation be traumatic or due wholly or in part to disease, especially in cases following blows upon the head and boxing the ears, as the statements of patient and friends are frequently influenced by personal motives. Study of the other ear may give valuable light.

The **prognosis** of simple injury and perforating wounds is good if the ear be clean and secondary infection does not take place, as the drum membrane quickly regenerates; in fact, it is the experience of most surgeons that it is difficult to maintain a permanent opening. Simple injury of the drumhead, as in surgical perforation, seldom has any deleterious influence upon the hearing. In fracture of the base of the skull attended by bleeding from the ear, rupture of the drumhead and lesions of the labyrinth usually occur; the prognosis is unfavorable as regards the hearing and sometimes as to life.

The **treatment** of most injuries of the drumhead after removal of foreign bodies and cleansing consists in letting well enough alone; the ear should not be douched, nor should solutions be instilled. The canal may be syringed or wiped out with warm saturated boric acid or 1 : 5000 sublimate solutions, etc., dried and dusted with impalpable boric acid, aristol, or iodoform powder, and the canal stopped with iodoform gauze and absorbent cotton. After twenty-four hours the dressing may be removed and renewed. Within a few days the healing will usually have so far progressed that unless extensively destroyed the membrane has been restored. Even after extensive operations involving the removal of the drumhead and ossicles, although necrosis may have occurred, and after the mastoid operation, if treated in this manner, infection and suppuration rarely ensue.

Acute Primary Inflammation of the Drumhead (Myringitis Acuta).—A diagnosis of acute inflammation of the drumhead is less often made than formerly. Its most common causes are said to be due to the entrance of cold draughts or cold water into the external canal. I have more often seen it after attempted removal of cerumen, foreign bodies, or water from the ears, after instillation of irritating or hot solutions (Plate 11, Fig. 8), or in connection with aspergillic inflammation of the canal (Plate 11, Fig. 12). There is slight pain, tinnitus, and a throbbing sensation, with but little deafness. At first there is hyperemia and later effusion of clear or bloody serum from the breaking down of vesicles, which may involve a portion or all of the dermal layer (Plate 11, Fig. 13). Some cases of otitis attended by slight serous discharge, followed by resolution after a few days, are of this form. Sometimes abscesses (Plate 11, Fig. 15) develop under the outer layer, but are usually followed by perforation, presenting a picture similar to acute suppurative otitis media. After the vesicular stage the membrane will have a macerated appearance, more or less of the dermal layer peeling and the redness disappearing (Plate 11, Fig. 12).

The **treatment** depends upon the cause. In all cases it is necessary to cleanse the canal by antiseptic solutions to prevent infection. The vesicles may be punctured, the ear insufflated with boric powder, and the meatus occluded by iodoform gauze and cotton. In severe cases, cupping, leeching, and hot applications to the side of the head may be necessary. Opiates may be given if the pain be severe, although when such is the case there is usually development of abscess, the puncture of which will relieve the pain.

Chronic Inflammation of the Drumhead (Myringitis Chronica).—Chronic inflammation of the middle ear is generally accompanied by implication of the drumhead. Chronic myringitis alone is very rare, although it is possible that such may be found after acute myringitis which has not gone on to resolution.[1] After inflammation of the canal has disappeared the drumhead sometimes remains affected, and this may be considered an independent disease.[2] The clinical signs are maceration of the dermal layer, redness and sometimes granulations upon the surface (Plate 11, Fig. 16). There is but little pain, and the hearing is but little affected. Tinnitus and slight malodorous purulent discharge usually exist. Middle-ear suppuration with unseen perforation is to be suspected and sought. In perforation of the drumhead polypi and granulations may form upon the edges.

The **treatment** is antiseptic. It consists in cleansing the canal and membrane by injections or brushing with solutions of boric acid, bichlorid of mercury, etc., after which a small quantity of finely powdered boric acid or aristol may be insufflated, or a small pledget of cotton saturated in salol-camphor or naphthol-camphor may be placed in the canal, to remain twenty-four hours and then be renewed. Granulations may be touched with tincture of chlorid of iron, nitrate of silver, chromic or trichloracetic acids. Instillations of solutions by patients are to be discouraged.

Infectious and skin-diseases, as well as the exanthemata, may affect the drumhead (Haug); the eruption of these and of syphilis is sometimes to be seen in the dermal layer. The pustule of small-pox may have been the cause of several cases of middle-ear suppuration which I have seen after this affection. Condylomata[3] of the auditory canal and drumhead have been reported by the writer and others.

New Growths.—Warts (Burnett) rarely occur on the drumhead, and are usually due to instillation of fluids. I have seen true epithelioma of the canal involving the drumhead. Pearly growths consisting of cholesterin crystals and molecular débris were found in a case of chronic suppurative middle-ear disease; true cholesteatomata are rare (Gruber). Calcification in the drum membrane is frequently found in the course of chronic otitis media (Plate 11, Figs. 17, 18), although it is seen when there is no other evidence of ear-disease (Plate 11, Fig. 19). The membrane becomes thickened (Fig. 20), thinned (Plate 11, Fig. 21), or opaque and perforated (Plate 11, Figs. 17, 22, 23, 24), as the result of chronic inflammation in the middle ear and canal. They are likewise due to trauma and ulcerations, such as occur in syphilitic or tubercular (Plate 11, Fig. 24) middle-ear disease.

Polypi usually arise from the tympanic mucous membrane; but are sometimes on the edges of perforations—most frequently at the posterior superior quadrant. Mucous polypi and myxomata are most common, although fibromata and angiomata[4] are seen. These growths are accompanied by malodorous otorrhea, and are but part of a chronic suppurative process which is usually attended by necrosis of the walls of the tympanum and of the ossicles, and their removal may be a needed preliminary to treatment for the chronic suppuration. Granulations are preferably removed by the small curette, and polypi by the cold snare, and their pedicles cauterized by tincture of the chlorid of iron, nitrate of silver, chromic or trichloracetic acid on a small pledget or fused on the end of a probe; but with these or with the galvano-cautery care should be taken that nothing but the growth be touched. Granulations recur unless the suppurative disease be healed.

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[1] Steuer: *Die haüfigsten Ohrenkrankheiten im Bilde*, 1895.

[2] Politzer: *Atlas der Beleuchtungsbilder des Trommelfells*, 1896.

[3] Würdemann: *Arch. of Otol.*, xxi., p. 303, 1892.

[4] Buck: *Trans. Amer. Otol. Soc.*, 1870.

ACUTE AFFECTIONS OF THE TYMPANIC CAVITY AND EUSTACHIAN TUBE.

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THE acute affections of the middle ear are of great importance, for three principal reasons: First, on account of the pain which usually accompanies them; Second, because of the deafness produced, which may become permanent; and Third, because they may endanger life by extension to the brain. Each of these reasons would be sufficient to demand the earnest attention of the physician. Together, they present a subject which he cannot possibly afford to neglect.

Pain.—Usually the first symptom to appear is "earache," so common in some families as to be thought one of the necessary ills of childhood. In nearly every case this is evidence of an actual inflammation of the mucous membrane lining the middle ear. A child "subject to earache" is in danger of deafness, and no care should be spared, not only for the relief of present distress, but in ascertaining and removing the cause. It will rarely be found, even after a single attack of pain, that the hearing of the affected ear is normal. This fact is likely to escape attention if one ear only be affected. After the suffering is allayed, all anxiety on the part of the parents and friends ceases. But if the hearing be compared with that of the healthy ear, the simplest test will show the defect; and a new interest should be at once awakened, and a new sense of responsibility aroused.

The pain may vary from a dull ache to the most intense anguish. Often the pain is most severe at night, causing loss of sleep to the patient and his family. It may nearly or wholly subside by day, leaving only a tenderness when the auricle is touched, which is discovered by the nurse or mother when making the child's toilet. In children too young to tell the cause of distress, its seat will often be pointed out by unconscious movements of the hand to the affected part. Frequently in young children, after several days of suffering, a discharge of pus from the meatus reveals the diagnosis to the astonished friends; so that when a child cries and shrieks from an unknown cause, the ears should be among the earliest organs to be investigated. The pain is not always confined to the ear itself, but extends to the adjacent parts; almost all the nerves of sensation on the affected side of the head may share in the distress, which is further aggravated by movements of the muscles, as in mastication. Eructation, coughing, and sneezing are greatly dreaded. All loud sounds increase the suffering. Frequently the pain extends to the teeth, especially if any of them are decayed, until the patient scarcely knows whether toothache or earache most predominates. The severity of the pain is to some extent a gauge of the violence and character of the inflammation, the severer form, especially when constant, indicating the probability of suppuration with all its attendant dangers. As in many other diseases, the presence of pain, when rightly interpreted, is fortunate, for it comes as a warning of impending danger to the hearing, demanding measures for instant relief, which at the same time shall furnish a safeguard against the rapid impairment of a delicate and sensitive organ.

Deafness.—Next in importance to the urgent necessity for the relief of pain comes the prevention and cure of deafness. Much has recently been written to impress upon the profession the need of the most careful attention to this subject; but it is a matter upon which too much cannot be said, and reiteration cannot be too frequent, since it has become known how much can be accomplished in this direction by preventive medicine and surgery. Heredity in this direction means the existence of local causes which may be successfully controlled; and no child should be allowed to acquire deafness because, as is said, "it runs in the family." On the contrary, such a tendency should lead to the earlier and more active fight against such a fate. The baleful influence of poor hearing upon the development of children is so disastrous as to call for our warmest sympathy for its victims and our most earnest efforts for their rescue. Blamed and misunderstood by his teachers for supposed inattention, neglected and ridiculed by his companions, the child who is deaf often actually becomes the stupid and useless creature which he is at first only in appearance. He becomes ill-natured and peevish in disposition, stunted and undeveloped in intellect. His whole career is blighted. But few forms of employment or industry are open to him. Even his physical development is hindered by his inability to engage in the athletic sports which his fellows delight in; and from the resulting debility and malnutrition he readily becomes a prey to any cachexia to which he may be constitutionally inclined, or any disease to which he may be exposed. Many of these evils might be avoided or relieved by a wise prophylaxis or by proper treatment. But owing to the prevalent ignorance on the subject most of the cases in the schools are neglected until the proper season for interference is passed. It is to be hoped that the time is soon coming when the examination of the ears and hearing of children by competent physicians will be a matter established by law, not only as a preliminary to the beginning of a course of education, but from time to time subsequently as promotions are made to higher grades. The result of this would, of course, be the enforced attention of both teachers and parents to this vital matter and the consequent medical treatment of those capable of improvement; the better understanding on the part of the teachers of some scholars whose slowness to learn has been ascribed to a different cause; and the elimination of those scholars who would require the special training in lip-reading, so useful to those whose hearing is defective. It is true that but few children would be found suffering from an acute attack of inflammation of the middle ear at the moment of examination; but most of those found to be deaf will have acquired their deafness from an acute attack; and many of them will be liable to future accessions of the trouble if preventive measures are not promptly taken.

Danger of Extension.—The third principal point of interest in acute affections of the middle ear lies in the fact of their liability to extend to the surrounding parts. Primary inflammation of the antrum and mastoid cells may occur, but in nearly every case the disease comes by extension from the middle ear proper. This may be followed by caries and necrosis of the bony walls of these cavities, and the disease may then extend inward to the membranes of the brain, causing a meningitis or abscess of the brain, with lethal result. There may be a like extension still more directly through the tegmen tympani, where the attic portion of the tympanum is separated from the brain only by the thinnest layer of bone, perforated by foramina for vascular anastomosis. Thrombosis may also result from contact of the diseased bone with the walls of the venous sinuses, with a result equally fatal. General pyemia may also ensue, either by absorption of purulent products or by rupture into the walls of a sinus. These possibilities should lead us to look seriously upon every painful manifestation of ear-trouble, and make us willing to submit to criticism for too much zeal rather than have to blame ourselves for not having taken prompt and efficient measures at the time when they could most avail. Let us then remember that in every case of acute otitis media we may by proper treatment be the means of saving patients from pain, from deafness, or from death. Too often they have been treated with indifference or neglect, resulting in the tacit permission for the use of remedies often both inefficacious and far from harmless. That these affections are trivial no one who has once witnessed the suffering or its results can for a moment maintain. It is not true that the diagnosis is very difficult. Any intelligent physician may feel himself competent for it. The use of that most important aid in physical diagnosis, the head-mirror, should be familiar to every medical man, not for the ear alone, but for the illumination of every orifice of the body, especially at night; and under many circumstances where both hands are needed for operation and manipulation. With this mirror, and the light from a window by day, or the light from the ever-ready kitchen-lamp by night, the inspection of the drum-membrane is usually easy. But nowhere in the physician's practice is gentleness and delicacy of touch more necessary. One careless thrust of the speculum or ungentle pull on the concha, and all intercourse between a young patient and the doctor may be at an end, except by the aid of a general anesthetic. The old-fashioned bivalve ear-speculum should never be used. It is awkward and apt to cause pain, and requires one hand to retain it in its proper position. Should it be necessary in order to complete a full inspection for the purpose of diagnosis, it is proper to resort to general anesthesia; and if operative interference be found necessary, this condition may be taken advantage of to complete the procedure.

Types.—As to the usual distinction between catarrhal and purulent inflammation of the middle ear, it is difficult to draw the line in making the diagnosis. Only after the disease has run its course can we tell which form we have had to deal with. If we could always know the cause of infection, this, with the severity of the symptoms, would furnish an early indication. But this is not always possible. It is therefore better simply to look upon cases as more or less severe and not of a wholly different character.

Causes.—The acute affections of the middle ear come most frequently by extension from the naso-pharynx. Consequently the exanthemata, and especially scarlet fever, are among the most frequent causes of a systemic nature. A large percentage of the inmates of the institutions for the deaf date their infirmity from an attack of scarlet fever in childhood. In measles the ear is still more frequently affected. It has recently been shown that the ears are probably involved in every case of measles. An exudation containing the specific organism of measles is formed on the lining mucous membrane of the tympanum by the eruption. But unless this be mixed with one of the pyogenic germs, this exudation is rapidly absorbed without perforation of the drumhead and without injury to the hearing. The deafness of typhoid fever is caused usually by a catarrhal condition of the middle ear; but in this case also it seldom goes on to suppuration. As one result of the recent epidemics of influenza there has been a great increase of acute otitis media. This has been characterized by great intensity of pain and a greater tendency to suppurate, and consequently spread to the mastoid, than is usually the case in acute otitis media. Diphtheria may also produce inflammation of the middle ear, the characteristic bacilli being found in the discharge. The same is true of tuberculosis. Here the onset of the disease is comparatively painless; but it may result in great destruction of the tissues, both soft and bony, contained within the tympanum. Both a rheumatic and a gouty diathesis may favor or superinduce acute otitis media, either primarily or by extension from inflammation of the pharynx. Syphilis, in the secondary stage, when the naso-pharynx is involved, is often productive of acute otitis media, varying in all degrees of intensity. Later on, when the bones of the nose are diseased, the same result may ensue. Of all external causes, taking cold, in the ordinary sense of the expression, from exposure to draughts of air, or in any way productive of coryza, is by far the most frequent. Whooping-cough and the catarrhal affections commonly classed under the head of hay fever may also result in acute inflammation of the middle ear. Sea-bathing, if too frequent or long continued, is a common cause; and the same is true to a less extent of bathing in cold, fresh water. But it seems that the surf, either from its violence or from its saltness, is directly dangerous to the ear, especially if a perforation of the drum membrane exists. Perforation of the drumhead also admits air, which, from its temperature or from being laden with any of the infectious germs, produces inflammation of the mucous membrane. Acute otitis media may be the result of *adenoid vegetations* of the pharyngeal vault; and many children who are subject to earache will be found to have this cavity closely packed with this form of hypertrophic growth. This may act by causing a retention of the natural secretion through obstruction of the orifices of the Eustachian tubes, or by predisposing to naso-pharyngitis which is propagated by extension, until it reaches the cavity of the tympanum. The importance of the recognition of this condition cannot be overestimated.

Hypertrophied tonsils undoubtedly have a similar effect upon the ear; but the adenoid growths which so often coexist with them are no doubt more frequently responsible. Otitis media may also follow the intratympanic hemorrhage of Bright's disease. It may be produced by the extension of erysipelas from without. Trauma figures among the less common causes of middle-ear disease of acute form; the tympanum by its situation being greatly protected from external violence. But when a wound admits infectious germs, or when infection occurs from a rupture of the drum membrane by an explosion, a blow, or any other violent cause, inflammation of the middle ear may follow. The same is true of the destruction of the drum membrane by scalding or corrosive liquids or molten metals. Fracture through the temporal bone may also form an avenue for infectious germs. Among the rarer causes, perforations produced by mycosis or vegetable fungi of the meatus, or by accumulations of dried wax and epithelium, may lead to the same result. The teeth, both at the time of their development and eruption, and when diseased, are productive of much middle-ear trouble. During the first and the second dentitions, at the eruption of the sixth-year-molars, and at the appearance of the wisdom teeth, the ears are peculiarly liable to suffer from reflex irritation and inflammation. At all times of life caries and necrosis of the teeth and alveolar processes, with their accompanying ulcerations and suppuration, are closely connected with the production of disease of the tympanum. The examination of the teeth should, therefore, be a constant matter of routine in the examination of these cases.

That the causes, both immediate and remote, of the disease under consideration are so numerous and varied, shows the need of diligent research in every case, that we may avail ourselves of all indications from such sources, both for present treatment and for prophylaxis.

Symptoms.—Of the symptoms of acute otitis media, next to the pain, which we have already considered, comes tinnitus. Subjective noises of some kind are rarely absent. A thumping, pounding, or beating sound, synchronous with the heart's action, is most common in the earliest stage of the disease. Children often mistake these sensations for real, objective noises; and an inquiry as to their meaning or cause is sometimes the first indication of the existence of disturbances in the ears. Later, the tinnitus is of a more steady and continuous character, described as rushing, roaring, singing, or buzzing. Those sounds of a pulsatory or rhythmic character are due to the increased circulation in the arteries and dilated capillaries in close contiguity to the sound-perceiving termination of the auditory nerve. Those of a steady and continuous character are due, at first at least, to increased venous circulation, which is heard by the ear itself in the same manner. In a later stage there may also be tinnitus due to pressure on the contents of the labyrinth through the oval and round windows from swelling or retained secretion in the middle ear. To children these noises are often terrifying. In all cases they are productive of a greater or less degree of nervousness and distress.

Deafness is the next objective symptom noticed by the patient. In the milder cases some days may elapse before the hearing becomes much impaired. Slight degrees of deafness may not at first be noticed by the patient, especially if the affection be unilateral. But soon familiar sounds, like the ticking of a clock, become inaudible, then the patient begins to ask for a repetition of what is said by those around him, and finally hearing is for the time almost totally abolished. The degree of deafness, in the earlier stages at least, depends much upon the localization of the affection. Should the attic of the tympanum be most affected, the hearing may suffer but slightly at first, although the pain be most severe. When the Eustachian tube is most affected, the stopped-up feeling predominates over the deafness. When the whole lining of the atrium is involved at the outset, the deafness is most marked. Besides deafness there may be the modified hearing of autophony, in which the patient hears his own voice strongly changed and resonant. There may also be diplacusis, or hearing sounds in a different pitch from that perceived by the unaffected ear.

The constitutional symptoms are sometimes ushered in by a chill. There is general uneasiness, loss of appetite, and increased temperature; sometimes headache, dizziness, and possibly nausea are present. As in other acute diseases, the general disturbances will be greatest in patients of a nervous temperament.

If a tuning-fork in a state of vibration be now applied to the vertex or to the teeth, the sound will be heard more clearly in the affected side, the closed cavity with its thickened walls acting as a sounding-board to intensify the effect of the vibrations. Examination of the drum membrane usually reveals more or less redness; even in the early stages of the attack the hyperemia shows itself by beginning at the tympanic margin and extending toward the center with more or less rapidity. The vessels which follow the handle of the malleus, unseen in a state of health, now become visible. All the landmarks may be lost, as the hyperemia involves the adjacent portion of the dermoid meatus; swelling shows itself at any point according to the localization of the inflammation, and may also extend to the inner end of the meatus (see Plate 11, Fig. 8).

As in all inflammations of the mucous membrane, the secretion soon begins to increase. A serous exudation is poured out, which may sometimes be distinguished through the still transparent membrane, partially filling the cavity of the tympanum, like the liquid in a spirit level (see Fig. 495). In severe cases the cavity quickly becomes filled, and a few hours may suffice for the pressure of the confined liquid to cause a rupture of the drum membrane. As the Eustachian tube has been closed by the swelling of its lining membrane, the drumhead affords the point of least resistance, and becoming softened, yields to the pressure from within. Often the liquid takes on a purulent character, and may be seen pointing at some bulging portion of the membrane before a rupture takes place (Fig. 496). After the evacuation of the secretion, whether from spontaneous giving-way (Fig. 497) of the membrane, or from surgical interference, there is usually great relief from pain. The amount of discharge may be very slight, but is at times most profuse and continuous, so as to moisten many thicknesses of compresses and bandages. Often at first the secretion is tinged with blood, or there may be quite a free hemorrhage. In favorable cases the untoward symptoms now rapidly subside. The pain diminishes and disappears, the noises become less violent and annoying, the temperature falls, the patient is able to obtain rest, and the general recovery is rapid. The deafness, the last effect to disappear, gradually or sometimes quite suddenly gives place to perfect hearing. Unfortunately, many cases do not end so happily.

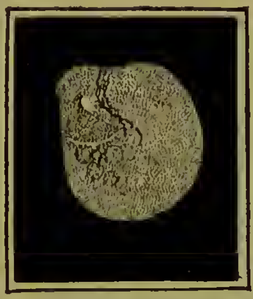

FIG. 495.—Acute catarrh of the middle ear, with bubbles in the fluid which nearly fills the drum cavity.

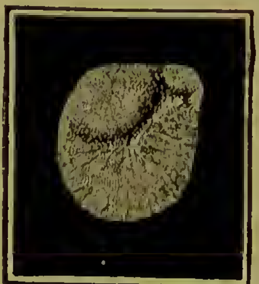

FIG. 496.—Injected drumhead bulging in the upper back of quadrant and above the short process.

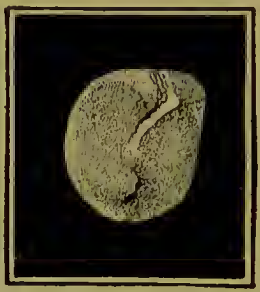

FIG. 497.—Pouting perforation of the lower back quadrant, showing a mere pin-hole at the apex of the nipple.

Treatment.—The first point in the treatment is to *remove, so far as possible, the cause.* But in most cases the patient is not seen until the disease is well developed, and preventive measures are now of no avail. However, when a naso-pharyngitis which has spread to the middle ear is still active, it should receive prompt and appropriate attention. Anything unfavorable in the patient's surroundings should be looked after, a mild and equable temperature should be established and the patient placed in bed; and quiet, both as regards freedom from noise and from excitement, maintained. If there be a rise in temperature, a saline cathartic should be administered. Tincture of aconite may be given in small and frequent doses, where the pulse is full and hard, until the feverishness is reduced. Opiates should be used but sparingly, except at the outset, when a full dose may be employed. When given later, by their anodyne effect, they mask the symptoms, and may deceive into a fancied security when the danger is not yet passed. Inflation by Politzer's method should be tried with care and gentleness. It sometimes gives great relief to pain by equalizing the pressure of air within and without the tympanic cavity. With closure of the Eustachian tube, absorption of air takes place through the mucous membrane lining the tympanic cavity. This produces a partial vacuum, draws inward the drum membrane, causing pressure through the chain of ossicles upon the labyrinthine contents, and at the same time retards the flow of blood, causing or increasing venous congestion in the lining mucous membrane and exudation into the cavity. When the effect of this procedure is favorable, it may be repeated once or twice daily; but when it increases pain or gives no relief, its use must be postponed until later in the treatment of the case. No simple measure is so helpful as the application of "dry heat." The hot-water bag of India-rubber is the readiest means of applying heat. This, when filled, should be covered with soft cloth and laid upon the pillow in contact with the ear. But still better, because of its lightness, is a bag loosely filled with common salt and heated in an oven. Moist and warm applications, like poultices in all forms, are to be avoided. They soon become uncomfortable by evaporation, and tend by maceration of its dermoid layer to promote rupture of the drumhead, already perhaps softened in its inner layer. They may also serve as the means of conveyance of all sorts of infectious germs, and in the end complicate far more than they benefit the disease. For this reason are injurious most of the popular remedies and poultices of all the vegetables in the kitchen-garden. So, too, all the varieties of vegetable oils and animal greases are harmful, their sole value having been to carry heat. The vapor of chloroform may be used with much benefit in mild cases in children. A few drops of the liquid may be placed in a spoon, and the vapor, which is much heavier than air, be poured like a liquid into the ear. Chloroform liniment applied about the ear with a bit of flannel is also valuable. Aseptic aqueous solutions containing local anodynes and anesthetics may be used judiciously in the early stage of an attack. The sulphate of atropia, four grains to the ounce of solution, is efficacious. Cocain hydrochlorate, in solution of from four to twenty grains to the ounce, is still more effective transiently; and better still is the combination of these two with morphin, *e. g.*:

℞. Sol. cocain hydrochlorat.,	10 % f℥j ;
Atropiæ sulph.,	gr. j ;
Morphiæ sulph.,	gr. ij.

Of this, five or six drops from a spoon previously dipped into hot water may be poured into the ear.[1]

The local abstraction of blood furnishes one of our most effective measures. The application of two or three leeches to the tragus, or just in front of it, may cut short the whole trouble. After they have filled themselves with blood and fallen off, the bleeding from the bites may generally be allowed to continue until it ceases spontaneously. This subsequent bleeding makes the natural leech more effective than wet-cupping. When leeches are not at hand, the artificial leech furnishes an excellent substitute, or any small knife can puncture the skin in front of the tragus, and any small cupping-glass will serve if the special instrument be not at hand. An ounce or two of blood may be taken, and if the relief experienced be but temporary, the process may be repeated. But when the simpler measures tried in quick succession have failed, or when the onset of the disease is such

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[1] Smaller dosage must be adopted if perforation be present.

that it is not likely to yield quickly to the other remedies, or when we find the earlier stages of the inflammation have passed before we have seen the case, paracentesis of the drum membrane must be made. This may be done with any long, slender knife, such as v. Graefe's cataract-knife, or a delicate bistoury, which should be first carefully sterilized. The most convenient instrument for the purpose is the spear-shaped knife (Fig. 498). The double-edged point should be longer than is usually made, so that in penetrating deeply it will continue to cut, and not, after pricking through the membrane, fail to enlarge the opening. The meatus should be disinfected by gentle irrigation with a 1 : 5000 warm solution of mercuric bichlorid, followed by mopping with absorbent cotton moistened with alcohol. A pellet of cotton dipped in a 10 per cent. solution of cocain should then be laid against the drum membrane for a few minutes to produce local anesthesia. This will not always be complete in an inflamed membrane, but the pain of the cut will usually be very slight and momentary. The point of selection for the incision may be where any swelling or tendency to point seems to indicate; but if there be no such local indication, the posterior inferior segment is usually chosen as the region where less injury is likely to be done by the knife to the structures within. The cut should be a free one of several millimeters' length and carried down to the tympanic margin for the purpose of drainage, and so as to divide the plexus of engorged vessels which is usually present there.

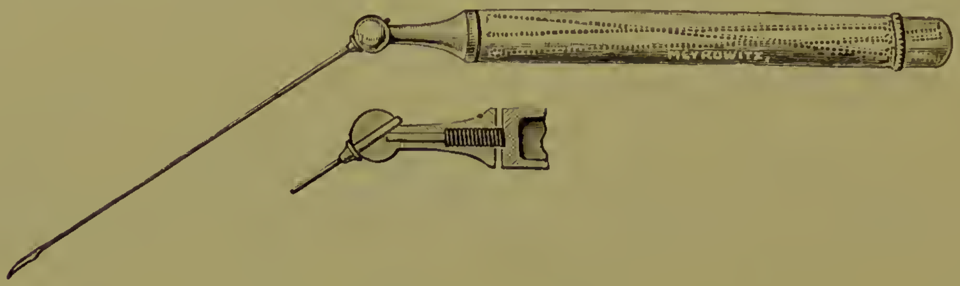

FIG. 498.—Sprague's pocket-case and handle for paracentesis, etc.

If the opening be made very early, there may be little or no secretion, and even the hemorrhage may be very scanty. If there be a purulent discharge, this may be gently washed away with the warm bichlorid solution, otherwise no syringing or other interference is necessary. A wick of absorbent cotton, moistened with bichlorid solution, should be inserted, a small compress of iodoform gauze should be placed over the meatus and a larger one over the whole ear, and secured by a loose bandage. Every kind of meddlesome interference which might cause reinfection should be avoided. The progress of the disease may now be arrested. The opening made by incision quickly heals, the pain is relieved, and the swelling is soon dissipated. The subjective noises cease, and the patient's voice as heard by himself resumes its natural tone. The hearing regains its normal acuteness; and in a few days there may be no remaining sign, either physical or subjective, of the serious disturbance which has taken place. When the process of resolution is less rapid, especially if the pain returns on the following night, more active after-treatment may be necessary. An anodyne may be given internally, and iodid of potassium should be administered, or a mercurial inunction used, or both. If, owing to a too rapid healing of the incision there be retained secretion, the operation may be repeated. If an abundant discharge occur, it must be removed by irrigation with warm antiseptic solution. When the deafness does not quickly disappear, the use of the Politzer's bag may again be indicated. For some weeks at least after an attack the patient should exercise unusual precaution against the effects of exposure to the weather, and overfatigue. Should the ear be sensitive to the cold, a bit of absorbent wool should be tucked into the meatus before driving or exposure out of doors.

SALPINGITIS.

Thus far we have considered the acute affections of the middle ear, with reference to the principal cavity, the atrium. The disease may be especially localized in the accessory cavities, the Eustachian tube, or the attic of the tympanum. When the Eustachian tube is the seat of the inflammation, the most marked subjective symptoms are produced by the sudden closure of the isthmus of the tube by swelling. The effect of this obstruction is the formation of a partial vacuum, causing retraction of the tympanic membrane inward and the transmission of pressure to the labyrinth, producing annoying tinnitus and dizziness, which may be distressing. Autophony is produced most frequently by this cause. The pain is located under the ear and inward toward the throat or at the root of the tongue, rather than deeply in the ear itself. All these symptoms may be productive of great malaise and general disturbance of the nervous system. Often there is a sensation as of a plug in the ear, which the patient endeavors to remove by thrusting the finger into the meatus. Cracking sounds are common, at times rhythmical. The tympanic membrane may show little if any hyperemia, but only great retraction. At first there may be a thin serous secretion, and later the tube may be distended by a viscid and tenacious muco-purulent exudation, which may be discharged into the throat and from the mouth. By the rhinoscopic mirror the mucous membrane at the mouth of the tube may be seen to be swollen and covered with secretion.

The object of treatment will be first to relieve the local congestion and inflammation of the tube itself; and then by opening the closed passage to restore the rest of the apparatus of the middle ear to its normal condition. Mild aseptic sprays may be used through the nose and fauces, with gargles of a similar character and of hot alkaline solutions, to modify any existing catarrhal conditions of the nasal and pharyngeal cavities. The gentle use of Politzer's bag should then be tried, and if the obstruction is not too great, may be followed by immediate relief. Should the air not penetrate by this means, the Eustachian catheter should be employed. An instrument of pure silver which can be bent to any curve should be used, and should be heated to redness in the flame and plunged in a cold boric solution. Its use should be preceded by spraying or mopping the nose and the mouth of the tube with a 6 to 10 per cent. solution of cocain. The air should be thrown in very gently at first to evacuate the secretion from the tube and not to force it onward into the middle ear. Soon the air will be heard through the auscultation tube entering the cavity of the drum. Sometimes the sudden change of pressure causes transient giddiness or faintness. The hearing is improved at once, the tinnitus ceases or is diminished, the feeling of fulness is relieved, and the tympanic membrane will return more or less completely to its normal plane. At the same time proper remedies may be applied through the catheter to the mucous membrane of the tube. Of these, none is more effective than the weaker solutions of nitrate of silver. From 5 to 15 grains to the ounce will usually be sufficiently strong. Only a few drops should be used, and but little force applied in driving it through the catheter, as the effect is to be localized in the tube itself. This treatment should be repeated daily at first, and then at greater intervals until no longer required. In a few days, in most cases, the normal hearing will be restored as the swollen mucous membrane returns to its natural state. When, as sometimes happens, there is more permanent thickening or even stricture of the tube, dilation by means of delicate bougies passed through the catheter may be required.

INFLAMMATION OF THE ATTIC.

It is evident from this description that localized inflammation of the tube is less serious and less dangerous to the hearing than that of the atrium. When the lining membrane of the attic becomes inflamed, the condition is much more serious. The anatomical conditions are such that even slight swellings cut off the communication of this space from the atrium below. The bulkier portions of the malleus and incus, with their ligamentous attachments and folds of mucous membrane, nearly fill the communicating space between the two chambers, and but little swelling is required to complete the closure. The pain from the tension caused by the hyperemia alone soon becomes excruciating. As soon as inflammatory products appear, the pressure is still further increased. The flaccid membrane, already intensely reddened and contrasting strongly with the drum membrane proper below, becomes bulging and swollen over its whole extent, or forms pockets on one or both sides of the malleus along the anterior and posterior folds (see Fig. 496). This condition admits of little or no delay for tentative treatment. Although spontaneous rupture may give ease, it may be only temporary. A permanent opening in the flaccid membrane may result, with necrosis of the bony walls of the attic and of the ossicles, and the formation of adhesions which may impair the movements of the ossicles. Here a free and prompt use of the knife, under the same antiseptic precautions enjoined for the incision of the lower portion of the drum membrane, is both necessary and effective. Beginning just above the short process of the malleus, the knife, with one cutting edge turned backward, should be plunged deeply in, until it reaches a bony obstruction; then the cut should be prolonged until it strikes the posterior insertion of the membrane. Then with the other edge of the knife the division should be continued upward and backward for a quarter of an inch or more along the superior margin of the membrane, still cutting deeply, and dividing all the tissues until the bony wall is felt. This can be done in a satisfactory way only under general anesthesia. After the incision—which will be followed by free bleeding and the evacuation of pus if suppuration be already present, and oozing of serous effusion—the wound should be irrigated with warm bichlorid solution of 1 : 5000. A mesh of absorbent cotton should be left in the meatus to promote drainage, and the whole ear covered with iodoform gauze, as before described. The result is usually prompt improvement. The hyperemic tissues are relieved of their engorgement, and the pain will have nearly disappeared when the patient returns to consciousness. The incision, although extensive and deep, heals with remarkable rapidity and leaves no visible cicatrix. The after-treatment is the same as in simple paracentesis. However harsh and radical this operation may at first sight appear, it is so generally efficacious that its performance will never be regretted.

In the light of our present knowledge of bacteriology, nearly if not quite all the causes of acute inflammation of the middle ear are only the sources or excitants of bacteriological activity. No cavity of the body lined with mucous membrane is free from organisms of morbific character, which are ready to develop with amazing rapidity under favoring conditions; and the mucous membrane is a soil always ready to receive and nurture germs of the most virulent character. The nose and the fauces are always exposed to infection through the air; and that such infection is not always taking place shows what a wonderful defensive power against such morbific germs must exist when not in abeyance owing to disturbing influences. Usually the infection is at first by a single organism, either that of the systematic disease, of which the nasal trouble is a local manifestation, or by one of the less virulent forms, which has for some reason been called into activity. After the opening of the drum cavity by spontaneous or artificial means reinfection may take place, and a variety of the most dangerous cocci, with their foul odors and poisonous products, complicate the disease. Hence the necessity of maintaining the strictest antisepsis and of abandoning many of the remedies and means of treatment which formerly seemed to be most strongly indicated.

CHRONIC CATARRH OF THE MIDDLE EAR.

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The term *chronic catarrh* has, in my opinion, led to a very general misunderstanding among the medical profession in regard to the changes which take place in the middle ear in the disease under consideration. It would be much better to designate this affection as *chronic non-suppurative inflammation* of the middle ear. The word *catarrh* is so universally associated with some affection of the upper air-tract, that both the profession and the laity have come to look upon a chronic catarrhal otitis media as the result of an extension of an inflammatory process from the nose and naso-pharynx into the tympanum by contiguity of structure. Catarrh is not a disease, but a symptom, and from its derivation means a discharge. It may, therefore, result from various local lesions, and the idea so commonly entertained that catarrhal inflammation of the middle ear is always due to the extension of an inflammatory process from the nose or naso-pharynx is entirely unwarranted. The influence exerted by any affection of the nose or naso-pharynx is usually purely mechanical. Thus, in the case of adenoid vegetations within the naso-pharynx, the middle ear may suffer either from the direct pressure of the lymphatic tissue upon the mouth of the Eustachian tubes, causing a rarefaction of the air within the tympanum; or this lymphatic tissue may interfere with the return circulation from the tympanum, thus causing a dilatation of the veins within this cavity, and consequent congestion of the lining membrane. The obstructive lesions of the nose and naso-pharynx cause chronic middle-ear disease chiefly through their influence upon the tympanic blood current.

Etiology. — Chronic non-suppurative inflammation of the tympanum may follow an acute inflammation of the middle ear, or may be the result of repeated mild attacks of acute congestion of the parts, each successive attack slightly impairing the function of the organ. On the other hand, the disease may be so insidiously progressive from its beginning as to give no symptoms until it has existed for many years.

Heredity is supposed to be an important etiological factor. From my own observation, I am inclined to attach less importance to heredity than do most writers. It is true that we often find impaired hearing in successive generations of the same family. When we examine these cases, however, we not infrequently learn that the impairment in hearing has not been due to similar middle-ear conditions. The history is an unsafe guide in determining the etiological importance of heredity. The patient simply remembers that other members of the family have suffered from an affliction similar to his own, but can naturally give no information as to the nature of the local lesion. It would be absurd to suppose that a suppurative otitis media, causing impairment of hearing in one member of the family, should be at all responsible for interference with audition in successive generations. My own belief is that certain conditions of the nose and naso-pharynx, such as enlargement of the pharyngeal tonsil, relaxation of the turbinal tissue, enlargement of the faucial tonsils, etc., are hereditary. Any of these conditions predispose to inflammation of the middle ear; yet, in many instances, they exist without producing this result.

Occupation exerts an important influence, in that those who are obliged to endure exposure to sudden and severe changes in the weather are more commonly affected than those whose vocation enables them to guard against such unfavorable conditions. For this reason we find that the disease is more common in males than in females.

The various general diatheses, such as the rheumatic or gouty diathesis, can scarcely be looked upon as influencing the occurrence of the affection. The habits of life are factors, however, in producing disease. The abuse of alcohol or tobacco, prolonged mental or physical exertion, or, in fact, anything which tends to lower the general condition, may act indirectly as a cause for the disease under consideration. In certain slowly progressive cases the local affection seems to be due to interference with the trophic nerve-supply of the middle ear. This causes an impairment in nutrition of the tissues, and certain structural changes follow which lead to either a perversion or impairment of function.

As before stated, a large proportion of cases are associated with some obstructive lesion of the upper air-tract. This is particularly true where the chronic process follows repeated attacks of acute inflammation.

Of these local causes, the most important is probably enlargement of the pharyngeal tonsil. Enlargement of the faucial tonsils alone is seldom responsible for middle-ear involvement. As enlargement of the faucial tonsils is almost invariably accompanied by a similar condition of the pharyngeal tonsil, the etiological importance of the former can hardly be determined with certainty.

Affections of the nasal cavities, such as hypertrophic rhinitis, nasal polypi, deformities of the nasal septum, etc., act essentially in the same way as does enlargement of the pharyngeal tonsil. These conditions either cause a rarefaction of the air within the tympanum, or interfere with the blood supply directly.

In atrophic rhinitis I am inclined to believe that the process within the middle ear is a simple concomitant of the nasal disease, and not a sequel to it. Atrophic rhinitis depends upon impaired nutrition of the lining membrane of the nasal chambers. A similar condition in the middle ear would be more probably due to a cause similar to that producing the nasal lesion than to this local disorder itself.

Pathology.—Non-suppurative inflammation of the middle ear may be either hypertrophic or hyperplastic in character. By the hyperplastic form I mean a condition ordinarily known as *sclerosis of the middle ear*, which may occur either as an idiopathic affection or as the result of a preceding hypertrophic condition.

Hypertrophic Inflammation.—The mucous membrane within the tympanum is swollen, the blood supply is increased, and at length, actual tissue hypertrophy occurs. The Eustachian tube, forming as it does a portion of the middle ear, participates in these changes. The mucous membrane is edematous, and the lumen of the tube is diminished in caliber. In the earlier stages the membrane of the tube is simply swollen, there being no tissue hypertrophy. This is particularly true of those cases which follow acute catarrhal otitis media, or where there have been recurrent attacks of acute congestion. If this engorgement continues, there is a development of new connective tissue within the walls of the tube, and the passage gradually becomes more and more contracted. As a result, the intratympanic pressure is diminished, and the drum membrane and ossicular chain are forced inward toward the inner bony wall of the middle ear. The drum membrane is gradually stretched, so that when the caliber of the tube is restored, the drum membrane is much relaxed. Certain inflammatory changes take place in the middle ear, depending directly upon the displacement of the tympanic membrane and of the ossicular chain. The crowding of the ossicles against each other and against the internal tympanic wall aggravates the inflammatory process within the middle ear. As a result, adhesions are formed between the inner wall of the tympanum and the ossicular chain. The tensor tympani muscle gradually atrophies from disuse, the muscular fibers disappear and are replaced by connective tissue. After this has occurred, even if the Eustachian tube regains its normal caliber, the malposition of the ossicles and membrane persists owing to the rigidity of the atrophied tensor tympani. If the drum membrane is atrophic, it may bulge into the canal upon inflation beyond the plane of the annulus, the ossicular chain remaining immovable.

We have spoken of the development of adhesions between certain portions of the ossicular chain and the adjoining bony walls of the middle ear. While this process may take place in any portion of the cavity, it occurs most frequently in the region of the oval window. The adhesions are most frequently found either between the posterior crus of the stapes and the corresponding wall of the oval niche or between the crura and inferior wall. Less frequently adhesions develop above the stapes or in front of it.

In certain instances the inflammatory process is exceedingly slow. It is in these cases that we often find a serous effusion in the tympanum, the engorged vessels unloading themselves of the fluid elements of the blood. Such an effusion may fill either the entire tympanic cavity or may be sacculated in the reduplications of the mucous membrane.

When the hypertrophic process changes to the hyperplastic variety, the cellular elements of the newly-formed connective tissue are changed into dense fibrous tissue. In the Eustachian tube this transformation causes the stenosis to disappear, and the canal may become even abnormally wide. We frequently find, therefore, that although the tube is perfectly free, the hearing is greatly impaired. Where the process is hyperplastic from the first, the lining membrane of the middle ear is gradually transformed into dense fibrous tissue.

Increased tension within the middle ear causes increased labyrinthine pressure; and in cases of long standing the perceptive portion of the auditory apparatus seldom escapes entirely.

The actual changes which take place within the labyrinth are sometimes the result of a chronic inflammatory process induced by this increased pressure. Where no pathological lesion can be demonstrated by microscopic examination, it seems that the function of the auditory nerve is to an extent ablated from disuse.

The disease in question is seldom unilateral, both ears, as a rule, being involved. Rarely, however, are both organs affected to the same extent, the disease usually beginning upon one side, and attacking the other at a later period. In the slowly progressive cases the disease may be so insidious as to entirely escape the patient's attention until the second organ is involved.

This secondary process seems to particularly affect the perceptive apparatus, although the middle ear does not entirely escape.

Symptoms.—These depend upon the particular course pursued by the disease. Those cases following acute inflammation will naturally give a history of successive attacks of otalgia. In the slowly progressive cases, however, pain is not a prominent symptom, whether the disease is of the hypertrophic or hyperplastic variety. The symptom which first attracts the patient's notice is usually the appearance of subjective noises. These vary greatly in character in different cases. The patient will sometimes complain of a pulsation in the ear, synchronous with the cardiac pulsations. In other instances the noise may be described as a deep rumbling sound ; again, it may be high-pitched, and is often compared by the patient to the sound of escaping steam. These noises may be constant or intermittent. They are usually exaggerated by physical or mental exertion, by a cold in the head, or by impairment of the general condition. Especially in the hyperplastic form of the disease the subjective noises may attract the attention of the patient before any defect in hearing is discovered ; but sooner or later the impairment in audition will be recognized.

The hearing may be considerably impaired before the patient becomes conscious of the fact. For this reason, cases seldom present themselves in the very early stages of the disease, but only when the hearing has fallen considerably below the normal standard. Patients usually notice that, while in dialogue the hearing is fairly perfect, they are unable to hear clearly when several are talking at the same time. Various sounds, such as the tick of a watch, the sound of the acoumeter, etc., may be perfectly heard, and yet the patient will be conscious of a certain deficiency in hearing. It often happens that the power of audition fluctuates greatly. At times the hearing will be excellent, while at other times the impairment will be quite pronounced. A common complaint is that the hearing becomes less acute whenever the patient has a "cold in the head," and not infrequently that after each successive attack it remains less acute than before. It is not uncommon for the hearing to be greatly influenced by certain muscular movements ; thus, many hear less acutely while masticating the food than at other times. The acts of mastication and deglutition may also be accompanied by clicking or snapping sounds in the ear due to the separation of the walls of the Eustachian tube by the contraction of the palatal muscles.

Again, the hearing may vary with the position of the head. In the erect posture it may be perfectly normal, while on lying down or on tilting the head far back it may be greatly impaired. This symptom usually indicates the presence of fluid in the tympanic cavity. When the head is tilted backward, the fluid flows into the posterior portion of the tympanum and covers the oval and round windows, thus interfering with sound-conduction. When, however, the head is bent forward or held erect, the fluid changes its position, leaving these regions free.

While vertigo is not a common symptom in these cases, it is occasionally met with, and may be very pronounced. This is particularly true where there is a collection of fluid in the tympanic cavity, the vertigo becoming very severe when the position of the head causes the fluid to cover the oval and round windows.

It must not be understood that the presence of fluid in the middle ear is the sole cause of tympanic vertigo. While dizziness is not a common symptom in these cases, it is by no means a rare one, and is sometimes exceedingly severe. The pressure upon the labyrinth, due to increased tension of the ossicular chain from the development of adhesions, is sufficient to cause the symptom. It may be said, in this connection, that the length of time which a vertigo has persisted is no indication that relief will not be obtained by relieving the middle-ear condition. If examination by means of the tuning-forks shows that the middle ear alone is involved, the results of treatment are usually satisfactory. It might appear that, in cases of long standing, relief of the increased labyrinthine pressure could be obtained by surgical measures only. This is not the case, however; and we often find that the restoration of the Eustachian tube to its normal caliber will immediately relieve the vertigo.

Most of these patients hear better in a noise than in a quiet place; and, under the same conditions, the subjective noises are often less severe. This is explained by the fact that, when the ossicular chain is rigid, a certain amount of force is necessary to set it in vibration. When, however, the resistance has been overcome, very slight variations in this force are recognizable. For this reason, these patients usually hear better in a railroad train than does an individual with normal hearing (paracousis Willisii).

As the disease advances, the subjective noises, which at first have been distressing, may become less severe or disappear entirely. This is usually indicative of labyrinthine involvement, and is probably due to the fact that the portion of the perceptive apparatus concerned in the recognition of sounds of this particular character has been destroyed.

The appearance of tinnitus in the previously healthy ear should always be looked upon as a grave symptom. The sounds are generally of a high pitch, and probably depend upon certain changes in the cortical auditory area. As we know, each cortical auditory center receives fibers from both auditory nerves, but chiefly from the nerve of the opposite side. When the labyrinth of one side is involved as the result of chronic middle-ear inflammation, the opposite cortical auditory center is affected, and, as the disease progresses, this cortical lesion interferes with the function of those fibers from the labyrinth of the same side, so that the disappearance of tinnitus in the ear first involved is usually followed by subjective noises in the opposite ear.

Diagnosis.—**Physical Examination.**—The changes visible upon speculum examination often give no indication of the degree of impairment of function. The drum membrane may appear fairly normal as regards position, color, luster, and structure, and yet the hearing may be very much impaired. On the other hand, fairly good hearing may exist where the drum membrane and ossicular chain give undoubted evidence of intratympanic inflammation. The most common change is displacement of the drum membrane inward. The handle of the malleus is fore-shortened, and the short process is unduly prominent. The tympanic membrane itself may be thickened over certain areas and atrophic in other parts. A fore-shortening of the handle of the malleus indicates displacement of the ossicular chain inward. In many cases this retraction is but slight, and yet extensive changes have taken place in the middle ear. Adhesions within the tympanic cavity may cause a rotation of the malleus upon its long axis, so that the manubrium may appear broader than normal. Here the direction of rotation is from behind forward. Rotation in the opposite direction is accompanied by considerable retraction of the tympanic membrane, and the manubrium appears narrower than normal from the fact that the edge of the prismatic shaft is presented to view instead of the broader external border.

The presence of adhesions can be demonstrated by the use of the Siegle speculum. Examination with this instrument will show that the drum membrane and ossicular chain no longer move outward as a whole, when the air in the canal is exhausted. With each act of rarefaction, certain portions of the drum membrane will be drawn outward, while the ossicular chain will either remain immovable, or more frequently the handle of the malleus will seem to rotate upon its long axis, motion outward being prevented by adhesions to the internal tympanic wall.

In the hyperplastic variety of the disease, atrophy of the tympanic membrane is commonly present. This may be so marked as to render the structures in the middle ear clearly visible. In the upper posterior quadrant the descending process of the incus, the posterior crus of the stapes, and the tendon of the stapedius muscle can frequently be recognized. Owing to the tenuity of the membrane it is often found to be relaxed as the result of sudden and violent changes in the intratympanic pressure.

Catheterization in the hypertrophic cases shows a narrowing of the Eustachian tube, most marked upon the more affected side. If there is fluid in the tympanum, its presence will be characterized by bubbling or crackling noises as the air enters the cavity. Extensive adhesions within the tympanum will occasionally produce creaking and strident sounds upon catheter inflation.

In the hyperplastic variety of the affection the Eustachian tube will be found abnormally wide, air entering the middle ear very freely. Sometimes one tube will be abnormally patent, while the other is narrow. This simply means that the process has advanced farther on one side than on the other, and that in the ear first affected the hypertrophic process has changed to the hyperplastic form.

Functional Examination.—In investigating the hearing, we have to deal first, with quantitative, and, second, with qualitative, audition.

By quantitative audition we mean the distance at which any given sound, such as the tick of the watch, the click of the acoumeter, or the sound of the human voice, is heard, as compared with the distance at which the same sounds are perceived by the normal ear. Qualitative audition, on the other hand, is the perception of all sounds of the musical scale between the certain limits—these limits being known as the lower-tone limit and the upper-tone limit. The lowest musical tone perceived by the human ear is one in which the sounding body makes sixteen double vibrations per second, and the highest musical note recognizable is one in which the vibrations are repeated not less than 32,500 times per second. All intermediate notes between these limits are perceived under normal conditions. Obstruction to sound-conduction is characterized by the imperfect audition of particular notes in the musical scale, no matter whether this obstruction is located in the external auditory meatus or in the middle ear. The conducting mechanism is chiefly concerned in the transmission of the lower notes of the musical register, and in disease of the conducting apparatus hearing is first impaired for the lowest notes of the scale.

(1) *Quantitative Examination.*—In the disease under discussion, tests will show a diminution in the hearing distance, both for sharp sounds, such as the watch or acoumeter, and for the human voice. Of these two means of testing, the human voice is always preferable, and for purposes of comparison the whisper should be used. The patient should not be allowed to become familiar with particular words or sentences, and, therefore, numbers of two figures are commonly employed in testing. In examining one ear the patient should be directed to close the other with the finger, and to close the eyes also, in order to avoid the possibility of lip-reading. The patient is then

requested to repeat whatever is whispered to him. In addition to numbers, it is also well to employ short sentences. The average distance at which the various test numbers and sentences are heard should be taken as the whispering distance.

It will be found that these patients hear sharp sounds relatively better than they hear the human voice.

(2) *Qualitative Examination.*—To determine the limits of audition, vibrating tuning-forks of various pitch are held close to the ear to be tested, the opposite ear being closed with the finger. The lowest fork heard marks the lower-tone limit. In chronic non-suppurative otitis media the lower-tone limit will always be elevated, the lowest notes of the scale not being perceived. It is noticed, however, that the elevation of the lower-tone limit bears a certain relation to the whispering distance; that is, where the whispering distance is much reduced, the lower-tone limit will be very high; while, if the impairment in function is slight, the lower-tone limit will be more nearly normal. The upper-tone limit may be determined with a fair degree of accuracy by means of the Galton whistle. In cases where the labyrinth has not been involved secondarily, the upper-tone limit will be normal; any appreciable reduction at this end of the scale is indicative of labyrinthine involvement. In uncomplicated cases bone-conduction will be relatively or actually increased, and Rinné's test will be negative. The vibrating tuning-fork placed upon the forehead will be usually referred to the poorer ear, although this is not an invariable rule. This test is of less value in cases of long duration than in those that have existed for a shorter time. It is well known that in cases of long-standing the hearing may be better upon the side first affected than upon the opposite side; in other words, the progress of the disease is much more rapid in the organ involved secondarily. In such cases, Weber's test might be negative; but would still indicate the side upon which the intratympanic changes were more marked.

Prognosis.—The prognosis in these cases varies according to the age of the patient, the station in life, occupation, environment, and the duration of the disease. The prognosis is better in the hypertrophic than in the hyperplastic variety. In the hypertrophic form the condition of the upper air-passages is also an important factor in determining the course which the tympanic inflammation will pursue. Where the disease appears late in life the progress is much less rapid than where it affects children or young adults. The station in life is of importance, in that the disease will be less likely to advance in a patient so situated as to be able to guard against exposure to inclement weather, and to avail himself of the advantages of a favorable climate, than in one by whom these precautions cannot be taken. While I do not believe that it is possible to secure permanent improvement in these cases by a temporary change of residence, there can be no question that, if a patient can live permanently in a dry and equable climate, he will be able materially to retard or possibly to stop the progress of the disease.

The length of time that the disease has existed affects to a great extent the prognosis. If of long duration, certain structural changes have probably taken place in the tympanum which cannot be removed by treatment. On the other hand, in the early stage of the disease, when structural changes are less marked, proper treatment may restore the parts to a more normal condition, and will at least stop the further progress of the inflammatory process.

The rapidity with which the affection has advanced must be considered in giving a prognosis. Where the progress has been rapid and both ears have become involved in a short time, a much less favorable opinion can be given than where the same changes have taken place only after many years. In women any increase in the symptoms at the time of the menopause always warrants a guarded prognosis.

The condition of the upper air-passages exerts an important influence upon the progress of the disease within the middle ear. In many of these cases we find either hypertrophy of the turbinal tissues or a chronic inflammation of the naso-pharyngeal mucous membrane. In the younger patients the pharyngeal vault is often filled with adenoid vegetations. All of these obstructive conditions tend to aggravate the pathological process within the tympanum; and no treatment will be efficacious that does not include the relief of the upper air-passages.

Hyperplastic otitis is but little influenced by nasal and naso-pharyngeal conditions, and very little can be expected from treatment of the throat or nose. Most of these patients give little history of catarrhal trouble. It is quite possible that some pre-existing condition of the nose or naso-pharynx may have induced the aural affection, but in the atrophic stage this influence is no longer active.

Treatment.—The treatment depends upon the local condition found on physical examination in connection with the information obtained by a careful functional examination. The measures to be employed are radically different in the hypertrophic and hyperplastic variety of the disease.

It must be borne in mind that the general condition influences the progress of any local inflammation. Therefore, the patient must be kept in the best possible general condition; excessive mental and physical exertion must be avoided, as well as indiscretions in diet, the abuse of alcohol, tobacco, etc. In many of these cases the aural symptoms are aggravated by colds; certain hygienic measures should be adopted, therefore, to render the patient less susceptible to sudden changes in temperature. To this end the daily use of the cold bath should be advised, as well as the complete protection of the body by woollen undergarments.

In the hypertrophic cases one of the first objects of treatment should be to relieve any obstructive lesion in the upper air-passages. Adenoid growths in the naso-pharynx should be removed by operation, and normal nasal respiration should be secured by the correction of nasal obstruction. I do not mean by this that slight deformities of the septum must be corrected by surgical interference. It is only where the abnormality prevents free respiration that surgical interference is necessary.

Regarding the treatment of the middle ear, we find in these hypertrophic cases that the Eustachian tube is narrow. This must be restored to its normal caliber, in order to secure the proper ventilation of the tympanum. While many obtain satisfactory results by inflating with the Politzer bag, I freely confess that in my hands this instrument, as compared with the catheter, has been of little value in chronic cases. By inflation we not only restore the intratympanic pressure, but are able to medicate both the tube itself and the lining membrane of the tympanum by the introduction of various vapors. The current of air acts as a mechanical stimulant to the mucous membrane, both of the tube and tympanum, and this stimulating effect may be increased by the introduction of various vapors, as of menthol, eucalyptol, camphor, benzoin, iodin, etc.

The introduction of stimulating vapors causes an increased flow of blood to the parts, thus favoring the absorption of any recent inflammatory deposits or relieving chronic congestion due to the lack of vascular tone. When any stimulating vapor is used, it is wise to inflate first with air, until the tube is fairly patent, and to then introduce the vapor. In this way comparatively little of the vapor escapes into the throat, and irritation of the air-passages is avoided. The particular vapor to be used is largely a matter of individual preference. I have employed for a long time, with considerable success, the vapor given off by the following mixture:

℞. Menthol,
Camphor, *āā* ʒj;
Tr. Iodi, ad. ℥j.—M.

A pledget of cotton saturated with this mixture is placed in the middle-ear vaporizer. This instrument enables the operator to inflate first with air and then with the vapor, without disturbing the catheter.

If the obstruction in the Eustachian tube is of long standing, it will scarcely yield to inflation alone, and mechanical dilatation by means of Eustachian bougies will be necessary. Bougies of celluloid, whalebone, catgut, etc. are objectionable, as they cannot be rendered aseptic by boiling. They are also liable to break during the operation, thus leaving a foreign body in the Eustachian tube. For the last few years I have resorted to the following device: A piece of No. 5 piano wire, two or three inches longer than the Eustachian catheter, is selected, and at one extremity is bent so as to form a small hook about one-sixteenth of an inch long. The hook is then flattened upon the longer portion of the wire so that at this end the wire is doubled upon itself for a distance of about one-sixteenth of an inch. The wire is then passed through the Eustachian catheter until this doubled portion protrudes beyond the tip of the instrument for the distance of an inch and a half. The other end of the wire is then bent at right-angles as it leaves the conical portion of the catheter, so that its further passage through the instrument is impossible. Both the catheter and the wire are boiled to render them aseptic. A little cotton is then wound tightly about the doubled extremity of this wire, which is then drawn backward into the catheter, so that the cotton-tipped end protrudes just beyond the mouth of the instrument. The catheter is then introduced into the mouth of the tube in the ordinary way, and the cotton-tipped bougie is gradually passed through the Eustachian canal until it is felt to enter the tympanum. As the isthmus of the tube lies about an inch beyond the pharyngeal orifice, resistance is felt when the bougie has been introduced about an inch. This resistance is perfectly normal, and should remind the operator that he is approaching the tympanic cavity. A moderate amount of pressure forces the instrument through the bony portion of the tube and into the tympanum. As the Eustachian canal varies somewhat in length in different subjects, great care should be used in the final stage of the operation. If the wire is so bent that it cannot be introduced more than an inch and a half beyond the mouth of the catheter, it is practically impossible to do any damage. It is sometimes necessary to carry the instrument a little further, in order to be certain that it has entered the tympanum. If this operation is performed carefully, it is impossible to do any harm. The operator usually recognizes by the sense of touch that the bougie has entered the tympanum. Frequently the cotton-tipped extremity of the bougie can be seen in the tympanic cavity, through the drum membrane, on speculum examination. The tip of the bougie, under these conditions, appears as a white, opaque object, just behind and a little below the short process of the malleus. Pressure upon the bougie causes the drum membrane to move slightly outward, as can be easily recognized by the observer.

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One of the advantages of this device is that, when the cotton is tightly wound upon the wire and introduced into the tube, it absorbs a certain amount of moisture from the membrane, and thus becomes larger; an additional amount of dilatation is secured in this way. Another advantage is, that there is but slight friction between the wire and the catheter, and any resistance to the passage of the instrument must certainly be due to an obstruction in the Eustachian canal.

It is frequently of advantage to saturate the cotton pledget with a solution of nitrate of silver of a strength of from ten to sixty grains to the ounce. In this way the tube is medicated as well as subjected to mechanical stimulation. In hypertrophic cases of long standing, the careful use of the bougie is attended by the most gratifying results.

The injection of fluids into the middle ear through the Eustachian tube has been attended with doubtful benefit. Personally, I have no experience with this method of treatment. There is no reason why solutions should not be introduced into the middle ear in this manner, if both the solutions and the instruments are aseptic. It has always seemed to me to be more simple to medicate the middle ear directly through an opening in the drum membrane, rather than to inject the fluids through the tube.

When the tympanum contains fluid an attempt should first be made to evacuate this by means of catheter inflation. During the procedure the patient's head should be flexed on the chest, and, at the same time, should be inclined toward the opposite side. The current of air entering the middle ear will then displace the fluid and force it out through the Eustachian tube into the naso-pharynx. The use of stimulating vapors in these cases is also of advantage in hastening the absorption of the effusion.

As the persistence of an effusion depends usually upon some obstructive lesion of the nose or naso-pharynx, these parts must be put in the normal condition before permanent relief can be hoped for. If these measures fail, the fluid must be evacuated by incising the drum membrane. The incision should lie in the posterior segment of the tympanic membrane, close to its periphery, and should extend from below the tip of the handle of the malleus upward to the posterior fold. The term so often used, of "puncturing" the tympanic membrane to evacuate fluid, is responsible for many unsatisfactory results. A small opening allows but little of the fluid to escape, and does not empty the cavity. A free incision is necessary in order to secure the desired result. In performing this operation it is well also to incise the mucous membrane over the inner tympanic wall, thus depleting the engorged vessels and rendering recurrence less probable. Such incision is absolutely free from danger if the canal is sterilized before the operation, and if the instruments and the hands of the operator are aseptic. Moreover, the procedure causes but very little pain if a sharp knife is used.

After incising the tympanic membrane, it is often wise to inflate by means of the catheter to completely evacuate the fluid; and in some cases, where the effusion is viscid, it is well to wash out the tympanic cavity, with normal salt solution, through the Eustachian catheter. The incision heals in from twenty-four to thirty-six hours if aseptic precautions have been observed. At the end of twenty-four hours, if the margins of the incision have become agglutinated, it is well to guard against the accidental rupture of the freshly-formed adhesions by means of a paper disk applied to the surface of the drum membrane so as to cover the line of incision. The disk need not be removed by the surgeon, as it will be discharged spontaneously by the outward growth of the epithelium covering the tympanic membrane. It may be removed, however, at any time by the use of the ear-syringe.

A favorite plan of treatment in chronic catarrhal otitis media has been the systematic use of passive motion for the purpose of either breaking up or of stretching adhesions which have developed between the ossicles themselves or between these bonelets and the inner tympanic wall.

Lucae[1] has met with considerable success in these cases by the use of the "pressure probe." The device consists of a small tube, through which a rod terminating in a cup-like extremity passes. Within the tube is a small spiral spring pressing against the other end of this rod. The shaft of the instrument is introduced into the canal, and the cup-shaped extremity is applied to the short process of the malleus. By a rapid to-and-fro motion of the instrument the short process is pressed inward and then allowed to spring outward, the amount of pressure being regulated by the tension of the spring. In this manner it is claimed that the adhesions within the tympanum are stretched, and that the function of the ear is, in many cases, improved. I have had no experience with this method, and can, therefore, give no personal opinion as to its efficacy. The procedure is somewhat painful, and has never seemed to me to be free from danger. This I believe to be especially true where the process within the middle ear is not quiescent. Any attempt to forcibly manipulate the ossicles must cause a certain amount of mechanical irritation, and, therefore, must aggravate the condition which it is intended to overcome. This same criticism applies, I think, to modifications of Lucae's method of massage, advocated by Lester[2] and by Garnault,[3] who employ a small electric motor for actuating the masseur.

Systematic massage of the ossicles by alternately condensing and rarefying the air within the external auditory meatus, either by the method of Hommel,[4] by pressure in front of the tragus, or by the use of either the Delstanche masseur or the Siegle otoscope, has also been looked upon with much favor by some. Experience has not taught me that valuable results are obtained by these methods.

As the motions of the ossicular chain under the normal conditions are caused by aërial vibrations, it would seem reasonable that the most proper method of employing massage would be through the agency of some sounding body, and within the last few years various vibrometers, vibrophones, etc. have been devised. All instruments constructed for this purpose have, I think, been useless and worse. There is no question, however, that in certain cases the systematic exercise of the ear by means of the human voice may be of great benefit in improving the function of the organ, and the method has been successfully used by Urbantschitsch.[5] In employing this method it has been my practice to have an attendant read to the patient for a period of from five to fifteen minutes in a voice sufficiently loud to enable him to understand distinctly. Where the impairment of hearing is very marked the conversation-tube may be used, although this should be avoided if possible. It is advantageous, in case the patient understands more than one language, to read in different languages on succeeding days, to accustom the patient to recognize sounds varying widely in character. Such a method is tedious, but is often attended with excellent results. It is particularly advantageous where the ear has been practically useless for a long time and has then improved somewhat from local treatment. Under these conditions the auditory nerve seems to have suffered from disuse, and, although perfectly healthy, requires a certain amount of education before it can again perform its function. Here, of course, the procedure is one not only of massage, but, to a certain extent, one of education, familiarizing the patient with the significance of imperfect auditory impressions conveyed to the cortical centers.

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[1] *Archiv für Ohrenheilk.*, vol. xxi. p. 84.

[2] *N. Y. Med. Journ.*, June 8, 1895.

[3] *Précis des Maladies de l'Oreille*, Paris, 1895, p. 246.

[4] *Archiv für Ohrenheilk.*, vol. xxiii. p. 17.

[5] *Horübungen bei Taubstummen*, Wien, 1895.

Intratympanic Operations.—I have endeavored to detail briefly the various methods at our command for the treatment of these cases. When seen in the early stages, inflation, the use of the Eustachian bougie, and the treatment of the upper-air passages often yield excellent results. We frequently, however, meet with cases in which all of these measures fail, the middle-ear changes being so advanced as to render absorption of the new tissue impossible. The Eustachian canal is perfectly patent, the upper air-passages are normal, and the patient is suffering either from the result of a previous inflammatory condition or from a profound trophic disturbance within the middle ear.

I am aware that I stand almost alone in advocating surgical interference in these cases. My opinion is the result of my own personal experience, which has, perhaps, been extensive enough to warrant the position which I take. Where other methods fail, and where careful functional examination shows that the perceptive mechanism is not greatly involved, I believe that it is always wise to do an exploratory tympanotomy. Cocain anesthesia suffices to render the procedure painless, and at the same time is free from the objections attending ether or chloroform narcosis. For purposes of exploration, the tympanic cavity is best entered in the posterior and upper quadrant. In order to gain access to the middle ear, a flap of the drum membrane should be reflected downward and forward, so as to allow inspection of the incudo-stapedial joint and of the regions of the oval and round windows. When done under local anesthesia, the hearing can be tested at various stages during the operation, and if it improves the surgeon may complete the operation. On the other hand, if, after the stapes has been liberated by the division of adhesions in the oval niche and by disarticulation at the incudo-stapedial joint, there is no improvement in the hearing, the flap of the membrana tympani can be replaced and retained in position by means of a paper disk. Under aseptic precautions this operation is absolutely free from danger. If liberation of the stapes improves the hearing, the operator may proceed at once to remove the membrana tympani, malleus, and incus to secure permanent improvement. Excision of the two larger ossicles is performed with perfect ease under cocain anesthesia. I have not infrequently operated upon both ears in the same patient at different times. Had the operation been painful, the patient would scarcely have submitted to a second operation without general anesthesia.

One of the advantages of the procedure above mentioned is its value as a diagnostic measure. There are certain doubtful cases in which functional examination does not enable us to exclude labyrinthine involvement, and yet in which the condition in the middle ear seems to be sufficient to account for the functional impairment. An exploratory tympanotomy enables us to determine exactly how much improvement can be expected from removal of the drum membrane and of the two larger ossicles. If the exploratory operation gives negative results, the flap can be replaced, leaving the ear in the same condition as before operation. We are then certain that the impairment of function is due to some lesion of the perceptive apparatus. We often find, however, that we have underestimated the effect produced by the middle-ear lesion—the hearing improving beyond our expectations after the stapes has been liberated. In these cases completion of the operation yields very gratifying results.

Middle-ear inflammation upon one side usually leads to impairment of audition on the opposite side. We have to consider, therefore, not only the possible improvement in the ear operated upon, but also the effect of the procedure upon the opposite organ. From a number of my own cases I am convinced that the relief of increased tension in the conducting apparatus upon one side either checks or retards the involvement of the opposite organ, and in many cases improves the ear not operated upon. I should attach no importance to these cases, had they not been so frequent and the fact confirmed by other observers, notably Urbantschitsch.

Operative procedures of this character have been fairly satisfactory in my own practice, and after stating plainly to the patient that improvement cannot be absolutely promised, but that an operation offers the only chance for improvement, and that in a large proportion of the cases this is obtained, I still continue to perform these operations. My own results under cocain anesthesia are as follows: of 64 cases operated upon, 32 were greatly improved, 24 moderately improved, and 8 unimproved. In three of the above cases in which no improvement followed the operation, I should say that I did an exploratory operation only. The functional examination had seemed to demonstrate that the labyrinth was seriously involved, and operation was undertaken only as a forlorn hope. Disarticulation at the incudo-stapedial joint and liberation of the stapes being followed by no improvement, the flap of tympanic membrane was replaced and the ear left in its original condition. In one instance, where functional examination also seemed to show extensive labyrinthine involvement, the hearing was notably improved, not only in the ear operated upon, but also in the opposite ear. The improvement in general audition was so noticeable as to be remarked upon by the patient's friends.

A certain number of cases have been operated upon under ether anesthesia, and the results have been reported in my recent work.[1] For the reasons already stated, I always prefer to operate under cocain anesthesia.

Concerning the efficacy of constitutional treatment in chronic catarrhal otitis little can be said. Measures for improving the general health of the patient will naturally suggest themselves to the medical attendant. Where the labyrinth has been involved secondarily, the internal administration of pilocarpin may be tried. The results, however, are much less satisfactory than in cases of primary labyrinthine disease. In neurasthenic patients general medication and attention to hygiene will often do much to improve defective audition. Here strychnin in large doses and long continued is particularly valuable. I ordinarily begin with $\frac{1}{40}$ grain three times daily, and gradually increase the dose until the patient is taking $\frac{1}{20}$ grain four times daily. A fact which is often lost sight of is the fatigue which impairment of hearing causes, the patient making every exertion and fixing his whole attention in order to overcome his affliction.

Certain drugs have been recommended for the relief of tinnitus. My own experience has been that all are usually unsatisfactory. We may except, perhaps, large doses of hydrobromic acid, which afford sometimes relief. Naturally, if the general condition of the patient indicates the necessity for certain medication, such medication may incidentally relieve the subjective noises; but where the general condition of the patient is normal, very little relief can be obtained by internal medication.

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[1] *Diseases of the Ear*, New York, 1894, p. 512.

CHRONIC SUPPURATION OF THE MIDDLE EAR.

By ALBERT H. BUCK, M. D.,

OF NEW YORK CITY.

Etiology.—The causes of a chronic discharge from the middle ear are generally to be sought for in some primary acute inflammation of this region. In a few instances—as in the case of tubercular disease, there may be an entire absence of anything like an antecedent acute stage; and if present, our knowledge of the probable protracted continuance of the discharge justifies us in placing these cases at the very start in the category of chronic suppurative affections.

It was a widely accepted doctrine, ten or fifteen years ago, that a chronic suppuration of the middle ear almost invariably indicated either neglect or a lack of skill, experience, or courage on the part of the medical man who had the management of the primary acute attack. To-day, our better knowledge of the all-potent influence of micro-organisms in inflicting those lesions which determine, in most cases, the feature of chronicity, leads us to pass a more lenient judgment upon these men. Nevertheless, this earlier doctrine must still be accepted as fundamentally correct.

Aside from these few direct etiological factors, there are others which, although by no means direct causes, nevertheless play an important part in perpetuating the suppuration. There are three such favoring factors, viz.:

1. Lowered vitality.
2. Stagnation (intratympanic) of the fluid and solid constituents of the discharge.
3. The presence of a mass of hypertrophied lymphoid tissue in the vault of the pharynx.

Farther on in this article I will return to this subject and give it further consideration.

The influence of diabetes mellitus in favoring the development of widespread and deep-seated inflammation of the middle ear has doubtless received due consideration in the article relating to acute suppuration. It is in these cases, rather than in those of a chronic character, that this influence makes itself chiefly felt.

Pathology.—The cases of chronic suppuration of the middle ear which are encountered in practice may readily be subdivided, for our convenience in studying them, into three different and fairly distinct types or groups:

Group I. includes all those cases in which the tympanic membrane is usually perforated somewhere in the lower half, and in which no evidences of active inflammatory disturbance are discoverable. The discharge is scanty and free from any unpleasant odor. It is sero-purulent in character, but often has some admixture of mucus. At times it may cease altogether for a period of several days or weeks. Adults are affected less frequently than children.

This is the mildest type of chronic middle-ear suppuration of which I have any knowledge; and the cause of the non-subsidence of the discharge may be set down as a lack of tone in the blood-vessels of the tympanic mucous membrane—a *vaso-motor paresis.* In so far as this lack of muscular tone affects the blood-vessels of the mucous membrane of the Eustachian tube, we may expect to find a greater or less quantity of mucus intermingled with the discharge. In many of these cases a depreciated condition of the general health—a *lowered vitality*—plays an appreciable part in the persistence of the disease.

Group II. differs from the preceding group in only one essential respect: the discharge consists largely of ropy mucus, and the main cause of its persistence is to be found in *the presence of hypertrophied lymphoid tissue in the vault of the pharynx.* The latter condition not only excites a catarrhal inflammation of the tubal mucous membrane, but also causes the lower portions of these channels to become so narrowed that the secretion—the ropy mucus—cannot escape in the natural manner into the pharynx, but finds an easier outlet for itself in the opposite direction—*i. e.* into the middle ear and through the perforation into the external auditory canal. In these cases, as in those of the preceding group, the discharge is apt to be intermittent, sometimes stopping altogether during the summer months, and is entirely free from any unpleasant odor.

Group III. is characterized by several features which distinguish it fairly well from the other two groups. In the first place, the discharge is more distinctly purulent in character, but not necessarily any more abundant in quantity. It is apt also to have an unpleasant odor—sometimes positively fetid in character. An admixture of blood is not rarely observed; and, in addition to the fluid pus, we occasionally find some which has become inspissated until it resembles soft cheese.

In cases of long standing, desquamated epithelium is apt to form and accumulate in the recesses of the middle ear. Small flakes of it are also often found in the discharge, and at times even larger masses may escape spontaneously from the tympanum.

The actual lesions which lie at the foundation of the manifestations just described are localized areas of proliferative activity on the part of the tympanic mucous membrane, and often, at the same time, a more or less limited caries of the adjacent bone-tissue.

The location of the perforation in the membrana tympani is usually higher in this third group than in the other two. The posterior half, or

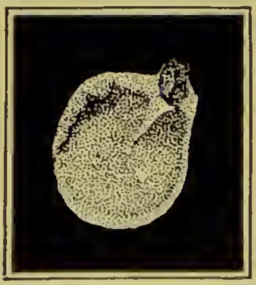

FIG. 499.—Right *mt.* showing malleus-head through a Shrapnell perforation, and up and back a slit-like opening with granular posterior lip, such as commonly marks caries of the incus and the adjacent tympanic margin.

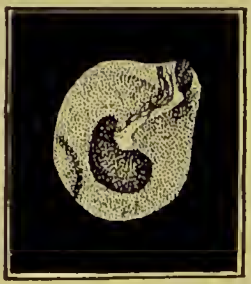

FIG. 500.—Reniform perforation at umbo and smaller opening above short process. Hyperplasia down and back, marking probable caries at this margin and in the "hypo-tympanic space."

the posterior superior quadrant (Fig. 499), is the common site in a large number of instances. The flaccid membrane is perforated (Figs. 500, 501) in a much smaller number of cases; and, finally, in comparatively rare instances a sinus in the bone, above or behind the tympanic membrane, serves as the outlet channel—the mechanical equivalent of the perforation—for all the products of intratympanic inflammation.

Finally, sclerosis of the mastoid process is so uniformly found to be associated with chronic suppuration of the antrum and vicinity that we are warranted in setting it down as one of the fixed characteristics of this third group. The practical importance of this fact becomes apparent when an attempt is made, in a case of chronic suppuration of the middle ear, to determine how seriously the antrum and neighborhood are involved. Before this law of mastoid bone sclerosis, or hyperostosis, was known, it was a frequent thing for physicians to deny the existence of any serious disease of the antrum because there were absolutely no outward manifestations of any such disease—no redness or swelling of the skin, no tenderness upon pressure over the mastoid process. The sclerosed condition of the overlying bone (Fig. 502), as we now know, offers an impenetrable wall to the advance of any such central focus of inflammation; and this sclerosis, as I have just stated, may be assumed to exist in every one of the cases belonging to this third group. It is therefore clear that in estimating the gravity of the deeper-lying disease in this class of cases we are not permitted to attach the slightest importance to the absence of outward evidences of inflammation.

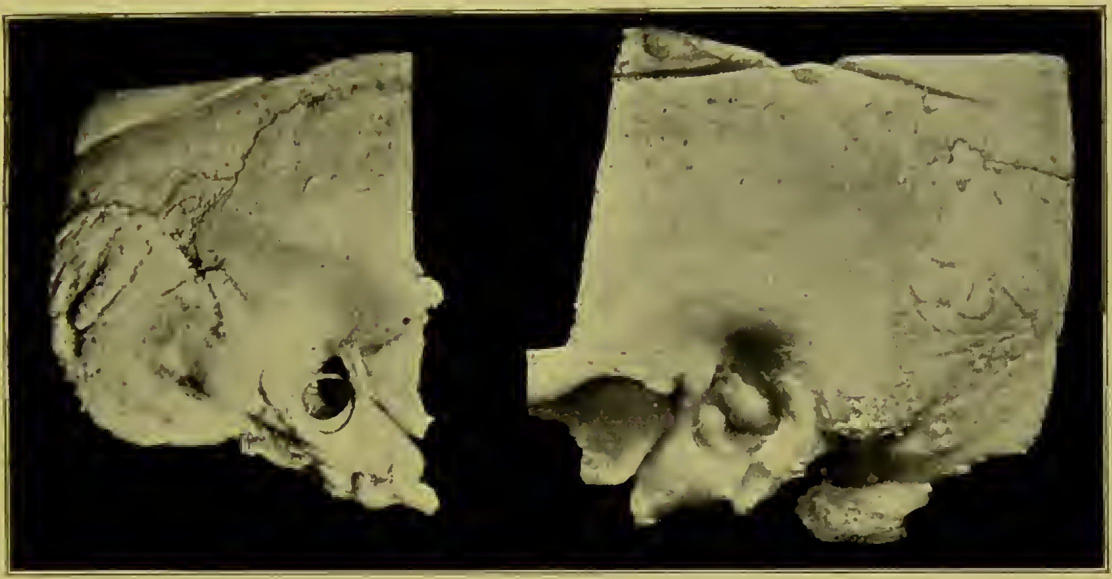

FIG. 501.—Left temporal of a child (right figure), showing bulging of upper back and lower front portions of drumhead. On the right a large central perforation is separated by a narrow band from the upper opening due to total loss of the flaccid membrane. All trace of the malleus is lost, but the incus and stapes seem normal (Dr. Randall's collection).

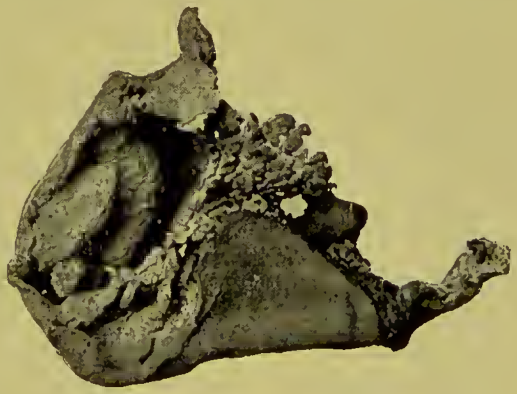

FIG. 502.—Metal cast of sclerosed mastoid in which but two large cells near the tip remain pneumatic. Contrast with Figs. 453, 454 (Randall).

The following pathological alterations and products observed in the cases which belong to this third group deserve further consideration: granulation-growths or polypi, bone caries, desquamated epithelium, and accumulations of cheesy pus.

Granulation-growths are extremely common in the middle ear in cases of chronic suppuration. They may develop at almost any point, but they are found oftenest, I think, at the lower margin of the entrance to the mastoid antrum. Their size is very variable, the largest one I have ever encountered measuring an inch and three-quarters in length. They are the product of an irritation applied to the tympanic mucous membrane at the localities from which they spring. This irritation may have been applied at the time of the original acute inflammation—an invasion of micro-organisms, for example, having stimulated the connective tissue of the mucous membrane to assume proliferative activity. Or the irritation may be of later date, and may even still, at the time when the growth is discovered, be in active force. Thus, for example, a small area of bone caries in the antrum, or at the point where it becomes merged in the cavity proper of the tympanum, is apt to secrete a very irritating pus of an almost corrosive character; and the constant flow of this over the tympanic mucous membrane soon causes the latter to proliferate and ultimately to form a mass of granulation-tissue, or a "polypus" —the term commonly employed when the mass has attained fairly large proportions. Then again, stagnating pus (independently of bone caries), in which the bacteria of decomposition are active, may also exert an irritating influence strong enough to cause proliferation of the mucous membrane with which it comes in contact.

In dealing with cases of this character, therefore, we are warranted in attributing the presence of the granulation-tissue either to bone caries or to stagnating and foul pus escaping from some point close at hand, and we should accordingly search for these conditions in every such case.

Superficial areas of *bone caries* are very often encountered in cases of chronic suppuration of the middle ear; in fact, it is no exaggeration to say that this lesion is the main if not the exclusive cause of the chronic discharge in the great majority of instances.

While the promontory or inner wall of the tympanic cavity and the region bordering on the tympanic orifice of the Eustachian tube are rarely the seat of a bone caries, every other part seems to be predisposed to the disease to an almost equal degree. The most extensive areas are doubtless those which involve the antrum. Smaller ones are found in the tympanic roof, at the posterior end of the tympanic cavity, on its floor, and finally on either the body of the anvil or the head and neck of the hammer. When caries involves such slender structures as the long process of the anvil, the lower half of the handle of the hammer, and the crura of the stirrup, these soon disappear altogether.

It is a very difficult matter to determine to what extent the ulcerative action is progressive. One thing, however, is certain, viz., that if foul pus, cheesy material, and desquamated epithelium be not allowed to remain for any great length of time upon the surface of such an area of bone ulceration, all carious activity promptly ceases.

It is also not entirely clear how bone caries is originally established in the middle ear. In former years it was customary to look upon the prolonged continuance of a high degree of intratympanic pressure as the chief cause of the trouble. Such pressure is undoubtedly competent to interfere seriously with the nutrition of the mucous membrane thus pressed upon, and ultimately with that of the underlying bone, which derives a large part of its nourishment from this mucous membrane. But it is now believed that the pressure simply plays the part of a favoring circumstance, and that the active factor in the process is the streptococcus or some other variety of micro-organism. These harmful agents first destroy the mucous membrane at a given point by entering into its blood- and lymph-vessels, thus shutting off its supply of nutriment, and then, as is almost certain, they in turn invade the adjacent bone-tissue and destroy that to a certain depth.

Accumulations of *desquamated epithelium* in the form of concentric laminæ or sheets are occasionally found in the antrum or in the epitympanic space. Such masses are often bulky enough to interfere seriously with the drainage of the cavity which they may happen to occupy, and by thus imprisoning the pus and other matters discharged they favor the development in them of putrefactive changes, which in turn stimulate the further production of epithelial laminæ. There is also reason to believe that the persistent expansive pressure exerted by such an elastic mass is competent to cause an absorption of the surrounding bony walls, thus leading ultimately to the formation of one of those large cholesteatomatous cavities containing cheesy material, cholesterin crystals, and concentric layers of desquamated epithelium which are occasionally encountered in dispensary, but rarely in private, practice (see pages 661 and 753).

Accumulations of *cheesy pus* owe their existence to those different factors which interfere with good drainage, as, for instance, a small perforation in the tympanic membrane, an indirect or tortuous outlet channel (a sinus in the bone, or an opening in the flaccid membrane), granulation-tissue, desquamated epithelium, etc. This condition and that described in the preceding paragraph go hand-in-hand and are scarcely separable.

Diagnosis.—The first duty of the diagnostician is to ascertain to which of the three groups enumerated above the case in hand belongs. If he begins, as very many men are apt to begin, by syringing the external auditory canal with tepid water, he will not gain as much knowledge in regard to the character of the discharge, its total quantity, and the particular direction from which it comes, as he would if he were to quietly remove it, little by little, with the aid of a cotton-carrier and small mops of absorbent cotton. By means of these he should have no difficulty in removing every particle of free fluid discharge from the walls of the canal, from the outer surface of the drum membrane, and even from a large part of the middle ear, when an adequately large perforation gives access to the cavity. In addition to whatever fluid may be present, there are often crust-like formations which must be removed before the tympanic membrane and surrounding portions of the auditory canal can be satisfactorily seen. Delicately constructed ring-shaped curettes with nicely rounded edges will be found to greatly facilitate the task of removing these obstructions. When once this has been accomplished, the physician will be in a position to determine more or less accurately the source of the discharge. If he has found, on removing the latter with his mops of absorbent cotton, that it is free from any unpleasant odor and is either sero-purulent or muco-purulent in character ; and if, besides, the perforation be found to occupy a position in the lower half of the membrane, he may consider this part of the examination as practically completed. If the perforation is of small size—as it is very apt to be in the cases which belong to the first two groups—polypoid masses or granulations are very unlikely to be present in the cavity of the middle ear, and he may therefore abstain from attempts to explore the latter with a probe. The vault of the pharynx is the region which next demands attention, and upon the results of the examination of this region will depend the settlement of the question whether the case belongs to the first or to the second of the groups mentioned.

As already stated, the presence in the external auditory canal of a bad-smelling discharge, or of one which is distinctly purulent (like creamy pus) in character, suggests the likelihood that bone caries, or granulation-processes, or both, exist somewhere in the middle ear; and that with these pathological processes is associated some kind of obstruction to the free escape of the resulting fluid and solid products. In this third group, therefore, the physician is called upon to enter the drum cavity with a suitable probe and to ascertain, if he can, just what are the true relations of things in each individual case.

When the perforation is located in the lower half of the drum membrane, the physician will not be able to explore the epitympanic space and the vicinity of the antrum, and fortunately these are the very cases in which such exploration is least often needed. If, however, it should seem necessary to explore these upper regions, what remains of the posterior half of the drum membrane may be excised and the required amount of room obtained in this manner. When this has been accomplished, or when the perforation already existing occupies the posterior superior quadrant, the entrance to the antrum and a large part of the epitympanic space or vault of the drum cavity may be reached with the end of the probe bent at nearly a right angle. The anterior end of this vault and the head of the hammer can only be reached when there is a perforation in the anterior superior quadrant or in the region of Shrapnell's membrane.

Granulation-growths or polypi, collections of cheesy pus or of cast-off epithelium, and an exposed surface of bone, or perchance a loose fragment of bone are the objects whose presence may be demonstrated by the skilful employment of a slender bent probe. The same instrument may also give information in regard to the absence of one or more of the ossicles, and it is competent to reveal to us the existence of pockets or sinuses in the bone, or of enlargements of pre-existing cavities (like the antrum) through destruction of the surrounding bony walls.

Probes made of coin silver are sometimes a little too stiff for use in exploring the middle ear. We should therefore have in our supply some which have been made of pure (unalloyed) silver, which can be given any desired curve with great ease. The tip should be expanded into a small knob; the stem should be very slender for a distance of at least two inches and a quarter; and, finally, the handle part of the instrument should be either four- or six-sided, and, proportionately to the stem, fairly thick.

It seems scarcely necessary to add that the physician who thus explores the recesses of the middle ear with a bent probe should have in his mind a well-defined picture of the relations of all the different parts; and the importance of delicacy of touch in the safe management of such an instrument must also be emphasized. The main thing is not to disturb the connections of the stirrup, through fear of injuring the hearing. But if this little bone has already been destroyed by disease, the need for such special care, as a matter of course, disappears.

Prognosis.—The cases which belong to the first group are of a mild and harmless nature. Even the hearing may be impaired to only a trifling degree; and besides, the interests of the fellow-ear are in no degree dependent upon the one which is affected with a discharge. Furthermore, if the disease is allowed to run its course without any treatment, the worst that may happen is, that the discharge will continue indefinitely to annoy the patient to a greater or less extent. The outlook, therefore, is not in any sense bad in cases of this kind. On the other hand, the arrest of the discharge may usually be obtained by proper treatment, but the permanency of this arrest cannot be guaranteed; for so long as a perforation in the drum membrane exists, the middle ear will show an increased sensitiveness to sudden changes in temperature, and will be liable to the entrance of irritating matters by way of the external auditory canal. Consequently, relapses will be likely to occur.

Equally mild and harmless are the cases which belong to the second group, but nevertheless they cannot always be considered—as may generally be done in regard to those which belong to the first group—solely with reference to the interests of the discharging ear. The fellow ear, if it possesses an intact drum membrane, is even more seriously imperilled by the presence of a mass of hypertrophied lymphoid tissue in the vault of the pharynx; and on this account, if not in behalf of the discharging ear, the physician is not permitted to speak of the case as being of a mild and harmless character.

On the whole, I believe that treatment is more uniformly successful in these cases that belong to the second group than in those belonging to the first. The perforation is more likely to heal after the mass of lymphoid tissue has been removed, and relapses are less frequent; for the lack of tone or the lowered vitality, which plays so important a part in the cases of the first group, is not an essential characteristic in these.

Very few cases which belong to the third group can be spoken of as being entirely free from elements of danger. When the perforation in the tympanic membrane is large enough to afford ample drainage outward into the external auditory canal, and when the source of the discharge is located at the posterior end of the middle ear proper (*i. e.* outside of the antrum) or at some point in the floor of that cavity, we may pronounce the case to be reasonably free from danger to life or health, even if no treatment whatever be carried out. But when the lesions upon which the discharge depends are located in the vault of the tympanum or in the antrum, the danger to life and health must be looked upon as—from this point alone—greater; and the precise degree of the danger depends upon the extent to which the free escape of the discharge is interfered with.

Certain danger-signals sometimes appear in the course of these chronic cases of suppuration of the middle ear, and show us the necessity of interfering promptly and radically if we wish to avert a fatal catastrophe. Intercurrent attacks of pain in or around the affected ear, paresis or paralysis of the corresponding facial nerve, evidences of disturbance of the circulation in the fundus of the eye, the development of metastatic abscesses or of the condition known as septicemia—these are the more important danger-signals which cannot safely be disregarded and which call for a grave prognosis. They indicate that at last the barrier which separates the focus of disease from the dura mater, or from the facial nerve, or from one of the venous sinuses which are so closely related to the bony surroundings of the middle ear, has been or is about to be broken down. In rare cases the signals are lacking, and the catastrophe arrives before we have time to ward off the danger.

Finally, the conditions present in these cases of chronic suppuration, especially in the young, are often such as to invite an invasion of tubercle bacilli; and tubercular disease of the bone in this part of the skull, if not eradicated, is sure sooner or later to infect the neighboring meninges or remoter parts of the body.

Treatment.—First Group.—In cases that belong truly to the first group the leading indication for treatment is to overcome a paretic condition of the muscular walls of the blood-vessels of the tympanic mucous membrane—metaphorically speaking, to brace them up, to give them tone. This may be accomplished in two ways—viz., by the employment of both constitutional and local measures.

Constitutional Measures.—The so-called tonics often answer the desired purpose in the class of cases which we are now considering. Cod-liver oil stands foremost on the list. Teaspoonful doses—disguised in the matter of flavor by a few drops of *crême de menthe*—should be taken two or three times a day for a period of several weeks. Strychnin in small doses ($\frac{1}{100}$ grain to $\frac{1}{60}$ grain) may also be utilized to advantage, either independently or in combination with the cod-liver oil. Finally, where the patient's means will permit, the stimulating effects of a change of climate or of a life in the open air may be taken advantage of in our efforts to secure a cure.

Local Measures.—Nitrate of silver is the most efficient vaso-motor stimulant of which I have any knowledge. A solution of this drug having a strength of from one-half of 1 per cent. to 1 per cent. will best answer the desired purpose in the cases now under consideration. It may be injected into the middle ear by means of a slender glass instrument called a "middle-ear pipette," the sharply-curved tip of which is passed through the perforation in the membrana tympani. After the solution has been injected, it should be allowed to remain undisturbed in the cavity, in order that it may be gradually absorbed by the mucous membrane, and in this way reach either the muscle-cells of the blood-vessels or the nerve-ganglia which control their action.

The same thing can be accomplished in a less perfect manner by first cleansing the external auditory canal thoroughly and then filling it (while in an upturned position) with the silver-nitrate solution. At the end of a few moments, when the solution has become somewhat warmed, pressure should be exerted, first backward and then directly inward, upon the tragus, thus forcing the solution through the perforation. By performing the act of swallowing, the patient may aid the physician in his effort to force the remedial solution into the middle ear and through the Eustachian tube.

Very often a single injection suffices to arrest the discharge, but in some cases it is necessary to repeat the operation several times, either daily or on alternate days.

The introduction of a very small mass of finely powdered burnt alum—as much as can be made to cling to the wet end of a slender probe—into the middle ear will sometimes prove effectual where the silver nitrate has failed.

As the blood-vessels in the vault of the pharynx are apt to be in the same paretic condition as those of the middle ear, it is well to make applications of silver nitrate to this region also. The mop employed should be saturated with a solution somewhat stronger than that injected into the middle ear. A 2 or 3 per cent. solution (10 or 15 grains to the ounce of distilled water) will be found sufficiently strong for most cases.

If the discharge is very scanty, as it usually is, no special provision need be made to remove it by the employment of the douche with tepid water. Nor is it advantageous to instruct the patient, as many physicians seem to be doing, to introduce powdered remedies—more particularly boric acid—into the external auditory canal. There are no processes of decomposition to combat, and the different powders thus prescribed possess no power, so far as I am aware, to give tone to the paretic blood-vessels of the middle ear. But even if these powders did possess such stimulating powers, it is not likely that they could effect any good, as it is more than doubtful whether they ever, when introduced in this manner, reach the middle ear.

Second Group.—The main indication in this class of cases is to remove the hypertrophied tissues from the vault of the pharynx and to restore this region to as nearly normal a condition as we can. How this is best to be accomplished is a question which doubtless has been fully answered in another part of this work (see page 1203). In all other respects the treatment is precisely the same as that described in the preceding section.

Third Group.—These cases present so many therapeutical problems for the physician to solve that only general principles can be laid down here for his guidance.

The *removal of all foul products* should be his first care. The slender probe, bent at a suitable angle and introduced into the middle ear directly upward toward the tegmen tympani, or upward and backward in the direction of the antrum, will be found of great assistance in loosening and dislodging solid matters like desquamated epithelium and cheesy pus. Hydrogen dioxid may then, by means of the slender glass pipette, be injected in the same directions, not merely for the sake of its germicidal properties, but also because it effervesces with such vigor that if some of it can be forced up beyond the mass loosened by the probe the expanding bubbles will often drive it down within reach of the slender angular forceps. By the aid of these two procedures one may gradually rid the vault of the tympanum, and sometimes even the antrum, of all the obstructing matters which interfere with the drainage, and so perpetuate the processes of suppuration. When the hydrogen dioxid almost ceases to effervesce—as it often does on the occasion of the third or fourth injection—it may be assumed that the middle ear has been fairly well cleansed of its foul accumulations. In any event it is not advisable to prolong one of these mining and scavengering sittings beyond a period of thirty or forty minutes. Before dismissing the patient for not longer than two or three days it is well to stow away in the newly cleansed cavity a few grains of iodoform, aristol, nosophen, or other powder of a character discouraging to germ life.

Often, after three or four sittings such as I have just described, the most careful examination will fail to reveal any evidence of newly formed pus. The powder will be found lying dry upon the parts, and we may dismiss the patient as relieved, if not cured. In a goodly number of instances the term "cure" is almost warranted in speaking of the results obtained by this plan of treatment, for I have known the relief thus promptly obtained to persist for a period of several years. In other cases a relapse will occur in the course of a few months, and the same brief course of treatment will have to be repeated.

It is only in very exceptional cases that the results which I have just mentioned can be obtained only after the removal of the malleus and incus, together with some still existing remnant of the drum membrane. It is claimed by some that it is better to perform this operation in every case of this kind, as by means of it a really permanent cure may be obtained in a larger percentage of cases. So far as I can judge from the published reports, relapses are about as frequent in the excision cases as in those in which the ossicles have been allowed to remain. The better plan, it seems to me, is to resort to excision only when the simple cleansing method described above fails to arrest the discharge.

In a certain number of cases we find the soft parts above and behind the limits of the drum membrane a good deal inflamed. In the presence of such a periostitis, and presumably osteitis, one must be very cautious about indulging in prolonged intratympanic manipulations. It is better to do only a very little of this sort of work at one sitting, and the patient should be instructed to douche the affected ear once or twice a day with as hot water as can be borne. Then, when this more active inflammation has been subdued, we may proceed with the regular routine as already described.

The second guiding principle in the treatment of these cases which belong to the third group is *the necessity of cutting or tearing away all granulation-tissue or polypoid growths* which project above the level of the surrounding mucous membrane. Such imperfectly formed tissue is of itself a source of suppuration, and then, besides, it often interferes by its mere bulk with the drainage of parts situated more deeply.

The various mechanical procedures which are employed for the removal of polypoid growths are discussed in another article of this work. Caustics, like chromic acid, nitric acid, silver nitrate, etc., are of very little use except in cases where the mass is too small to be removed by mechanical means.

The last principle to which I ought perhaps to call attention is *the desirability of scraping the surface of an area of bone caries.* This principle—at least in its applicability to caries of the middle ear—is so far inferior in importance to those of cleanliness, good drainage, and removal of all granulation-tissue, that a few words in relation to the matter will suffice in the present article. In the first place, there are not many cases in which effective scraping can be carried out ; and then, on the other hand, in the great majority of instances, proper cleansing measures followed by the application of a suitable antiseptic powder seem to be sufficient to bring about the desired cure. These facts, it seems to me, show plainly that the scraping of a carious spot of bone in the middle ear is not a matter of very great importance.

When our efforts to cure a case belonging to this third group fail, it may be safely assumed that the disease is not confined to the middle ear, but has involved other parts in the neighborhood. This allied subject has been confided to another writer, and I therefore do not need to say anything further with regard to it in this place.

COMPLICATIONS OF TYMPANIC INFLAMMATION.

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Pathological research, as well as clinical observation, demonstrates that inflammations of the tympanic cavity, as a rule, extend more or less to the mastoid process. This occurs in two ways, either through the Rivinian notch on the outside of the adjacent bone (*mastoiditis superficialis*), or through the *aditus ad antrum* into the interior of the mastoid (*mastoiditis profunda*). Both may be *acute* or *chronic*. They are infective diseases, produced by the various kinds of pyogenic micro-organisms, in particular the staphylococcus aureus and albus, the streptococcus, and the pneumococcus, which find their way into the cavities of the middle ear by way of the Eustachian tube.

The superficial mastoiditis, also called mastoid periostitis, is in the great majority of cases only the burrowing of muco-purulent secretion from the tympanic attic and neighboring cavities—especially the pneumatic cells in the squamous portion of the temporal bone *above*, *behind*, and *before* the outer ear-canal—on and beneath the periosteum on the outer side of the temporal bone. This variety is frequently seen in children, and most often runs an acute course. The periosteal and cutaneous swelling around the upper part of the ear pushes the auricle forward and outward. If the purulent exudation finds an outlet, either by spontaneous perforation or by an incision of the skin, in the ear canal or behind the ear, there is often a rapid and permanent recovery.

This happy termination does not occur so frequently in the other variety, the mastoiditis profunda or interna, also called mastoid empyema, which of all diseases of the ear is, on account of its consequences, the most dangerous. We shall describe the acute and the chronic forms separately.

ACUTE MASTOIDITIS INTERNA.

Etiology.—The causes are those producing acute middle-ear disease—viz. *acute rhino-pharyngitis*, as produced by various kinds of exposure, sea-bathing, rapid changes of temperature, and different general diseases, scarlet fever, measles, diphtheria, influenza, pneumonia, typhoid, etc. Some modes of treatment may produce mastoiditis—viz. violent inflation, the nasal douche, forcible syringing, operation in the nose and naso-pharynx—*e. g.* for adenoid vegetations, especially if followed by douching.

A particular disposition for the propagation of the inflammation into the mastoid cavities depends—

(*a*) On the anatomical structure of the mastoid: the pneumatic variety, it appears, being more disposed than the diploic and the compact; and when once invaded, this favors more than the two other varieties the extension of the suppuration into the cells remoter from the antrum and to the adjacent structures.

(*b*) On the kind of the pathogenic microbe. It seems that the pneumococcus and streptococcus are more prone to produce the severer and more extended forms of disease than the staphylococcus.

(*c*) On the nature of the primary disease—scarlet fever, diphtheria, and influenza being the worst. Among the constitutional dispositions tuberculosis and diabetes should be mentioned as favoring the development of mastoiditis.

Pathology.—In suppuration of the tympanum and attic the pus may by simple gravity or chemotaxis enter into the antrum and adjacent cells without producing an active suppuration in the mastoid, just as in a corneal abscess pus accumulates at the bottom of the anterior chamber. To wake up an active inflammation infective microbes or their toxins must enter the mastoid; ripe pus, like hypopyon, is inert. Infective purulent matter may enter from the naso-pharynx through the Eustachian tube and the tympanic cavity directly into the mastoid even without causing perforation of the drum membrane. In the mastoid it produces, according to its virulence, a *catarrhal* inflammation—congestion, edematous swelling, sero-mucous exudation—or a destructive, *purulent* inflammation of the mucous membrane, the periosteum, and the bone. In the first the mucous membrane is swollen, presenting many folds and depressions and scant, ropy secretion; in the second there are larger and smaller cavities filled with thin or creamy pus (abscesses), usually communicating with one another by narrow passage-ways (fistulæ); but not infrequently the abscesses in the course of the disease appear in different parts of the mastoid, first in the antrum, then either in the basal or apical, or in the anterior or posterior cells. In many cases these different foci develop successively, and when the suppuration is exhausted in the antrum, it appears in the upper, posterior, and anterior recesses or in the tip. In very severe cases the suppuration invades with great rapidity the whole interior of the mastoid, destroys the mucous membrane, breaks down the bony partition walls, and converts the mastoid into one large cavity filled with pus, shreds of mucous membrane, granulation-tissue, and decayed bone. The knowledge and diagnosis of these varieties of the morbid process are of great importance, for they indicate the direction in which the disease progresses.

Varieties of the Morbid Process.—The *catarrhal* form may terminate by resolution—the most frequent case—or may only be a preliminary stage of the *suppurative form*. The latter in a multitude of cases ends by evacuation of the pus into the tympanum or by perforation of the outer table of the mastoid, most commonly in the region behind the ear—the long-known *post-aural abscess*—or it may perforate the inner table, giving rise, according to the different regions it occupies, to the epidural abscess of the posterior or middle cranial fossa, or to the cervical abscesses, all of which we shall have to discuss later.

Symptoms.—Pain is usual and occurs (*a*) *spontaneously* in all degrees; in some cases, particularly in tuberculous patients, insignificant and not at all in proportion with the gravity and extent of the morbid changes; in other cases it is so severe that the patients have no rest day and night, commonly worse at night. The pain extends over the head, especially in the parietal region, but also in the occipital and frontal regions, and not infrequently shoot down the neck to the shoulder.

(*b*) *Pain on pressure* (tenderness). This symptom is very important, as it demonstrates not only the presence but also the location of the suppurative foci. If the outer bony table of the mastoid is thick and not affected, only firm (deep) pressure may elicit the pain when moderate pressure and percussion have failed.

As a localizing symptom the tenderness is most valuable. In the beginning of the affection pain from pressure right behind the upper wall of the meatus (the *fossula mastoidea* or antrum pit) will rarely be absent. It indicates suppuration in the antrum. Next in frequency is pain over the tip, the base, the posterior and anterior borders of the mastoid process.

Fever.—The temperature rising from 99° F. to 102° F., sometimes higher, with moderate acceleration of pulse, thirst, general malaise.

Profuse discharge from the ear; creamy, thin, sanguinolent, the latter in the severer cases; often suddenly lessening.

Redness and prominence (*bulging*) of the posterior and upper part of the tympanic membrane and the adjacent portion of the ear canal. This symptom is absent when the inflammation has left the antrum and continues in other parts.

Redness and swelling of the integument of the mastoid process, differing greatly in degree, in some cases being almost absent (see page 741), in others excessively developed, so that the knife enters 1 to 2 cm. before it touches the bone.

Course and Termination.—**Spontaneous recovery** in many instances occurs in one or several weeks; but the cases are not rare where it takes months, particularly when the course of the inflammation is not continuous, but intermittent.

Perforation, spontaneous or by operation, behind the ear or in the ear canal. Even in these cases the intermittent character is frequently manifest. It means that the suppuration exhausts itself in the antrum and appears in another place later on. Not rarely do we see cases in which the opening of the antrum is followed by an immediate improvement, but this does not lead to a permanent recovery; the fever returns, the painfulness moves to another place, and on opening there we strike another abscess, macroscopically without any communication with the antrum. This is particularly exemplified by collections of pus in the tip.

Caries in greater or less extent. This is commonly a protracted process, but in some cases of unusual severity it may develop over a large area in a few weeks.

Transition into the chronic state may lull us into false security.

Extension into the Neighboring Parts.—This and the preceding condition will be considered presently.

The **prognosis** of acute mastoid empyema is good if the proper treatment (rest, antiphlogosis, operation) is not neglected. If, however, the disease becomes chronic, it is dangerous to life in a degree we shall point out in treating of the intracranial complications of ear disease. Mastoid disease proper has no direct influence on audition.

CHRONIC MASTOIDITIS INTERNA.

We distinguish the following varieties:

Condensing Mastoiditis; Eburnation.—When muco-purulent mastoiditis runs a chronic course without external perforation, or with recurrent otorrhea and outward perforation, as we notice so often after the scarlatinal otitis, the mastoid process by plastic osteitis is gradually converted into a mass of compact bone, perhaps of reduced dimensions (see page 741). Before or after the condensation of the bone is completed or comes to a standstill, many patients complain of neuralgic pain, radiating from behind the ear over the adjacent side of the head (*mastoid neuralgia*), incapacitating them for prolonged mental labor (*aprosexia*). Neither by palpation nor pressure can any focus of disease be detected, and the otorrhea has stopped for months or years. The distress of such patients is so great that they willingly consent to surgical treatment. If the operation is done, the supposed deep-seated focus of pus is not found, even if, as I have done, the chiselling is pushed through the whole thickness of the bone, laying the [healthy] dura mater bare; yet these patients, according to the testimony of many aurists, lose their pain and aprosexia. It is not even necessary to go through the whole thickness of the bone to obtain this welcome effect.

Empyema of the Anterior Mastoid Cells, with Perforation into the External Meatus.—The preliminary symptoms are those of acute suppurative otitis media with mastoid involvement, the swelling and pressure-pain, however, being not so much over the mastoid as on the posterior wall of the ear canal. The swelling is diffuse and the painfulness rather dull when compared with the pointed swelling and the sharp pain of the furuncle. Any doubt in the diagnosis can be dispelled by a large and deep incision down to the bone in the whole length of the posterior wall of the meatus, as it was done in a successful case of mine reported in a paper published in 1893.[1] If such an opening does not give permanent relief, the diagnosis should be verified by the usual opening of the mastoid, as was done by A. Broca.[2]

This variety is apt to complicate a more frequent and graver extension of mastoid suppuration—viz.:

Empyema of the Apex of the Mastoid with Perforation into the Digastric Fossa, the so-called Bezold Variety.—When the purulent tympano-mastoiditis has lasted several weeks or months or longer, there is swelling and sharp painfulness over the tip of the mastoid, the head of the sterno-cleido-mastoid muscle, and in the grave cases along the muscle down the neck into the mediastinum (terminating fatally, case of Voltolini). In a case of Guye's[3] pressure on the neck and on the mastoid brought forth pus through a fistula in the posterior meatal wall. Guye opened the swelling at the head of the muscle and liberated a great deal of pus. Water injected into the abscess cavity escaped through a fistula in the ear canal: recovery. The perforation of the bone shows usually only a small opening in the lower medial wall of the tip. When the mastoid is opened and the tip laid bare by detaching the tendon of the muscle, pus occasionally will ooze through the upper end of the detached muscle when the latter is held between the fingers and stroked from below upward.

In some cases the pus escaping through a perforation at the medial surface of the tip of the mastoid into the digastric fossa does not travel down the neck along the sterno-mastoid muscle, but backward toward the spinous processes of the cervical vertebræ. Of this variety the writer has seen only two cases. The pus followed a deep and wide fistulous canal from the mastoid underneath a thick layer of muscles, which were laid bare by a long incision, with recovery. A good case is published by Dr. Henry F. Swain of New Haven, Conn., under the name of splenius abscess.[4]

Caries and necrosis of the mastoid are in the majority of cases the results of a chronic destructive, usually suppurative, inflammation which breaks down the bone and forms smaller or larger cavities filled with cheesy

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[1] "Otitic Brain Disease; its Varieties, Diagnosis, and Treatment, illustrated by Cases from the Writer's Practice," *Archives of Otology*, vol. xxii. pp. 143–162.

[2] See A. Broca et Lubet-Barbon: "Les Suppurations de l'Apophyse Mastoïde," Paris, 1895; Observation X: "Mastoiditis restricted to the Anterior Cells," p. 64.

[3] *Arch. of Otol.*, xxi. p. 320.

[4] *Arch. of Otol.*, xxvi., No. 1, 1897.

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masses—débris of mucous membrane and bone mixed with putrescent or dried-up products of secretion. They keep up a steady or intermittent offensive discharge.

A peculiar formation is the so-called **cholesteatoma** of the ear. This formation has been found as a globular mass in the temporal bone, a genuine tumor independent of any inflammation of the ear; but by far the greater number of cases present a scaly deposit which lines the cavities of the middle ear, especially those of the mastoid, and is always connected with chronic otorrhea. If the scaly masses form only thin layers lining the cavities, they represent the initial stage of cholesteatoma which Wendt has termed *desquamative otitis.* The theory of Bezold and Habermann is that epidermis penetrates through a perforation of the tympanic membrane into the middle ear, proliferates, and gradually fills and expands the neighboring cavities, forming *scaly masses* of a pearly color in concentric layers like an onion.

Their course varies in three directions: (1) They produce purulent inflammation, destroy the structures of the auditory apparatus, creating on the one hand large sinuses by converting mastoid, tympanum, and meatus into one large cavity which communicates with the air through the meatus or through a permanent opening in the mastoid—spontaneous recovery.

(2) They lead by proliferation of bone-tissue to eburnation of the mastoid—spontaneous recovery.

(3) They penetrate the cranial cavity and cause death by one of the otitic complications.

Another consequence of caries and necrosis is the separation of larger or smaller *portions of bone* (sequestra). Their formation in the mastoid is common. They are eliminated through perforations of the skin (fistulæ) either spontaneously or artificially. Exfoliation of larger portions of the meatal wall and the petrous bone, including the whole inner ear, have been observed, and it is surprising how people can live and how severe and fatal consequences are absent in so many cases and for so long a time.

In my collection there is a specimen of which the accompanying illustrations (Figs. 503, 504) give a true and life-size illustration.

Fig. 503 presents the *outer surface* of the left temporal bone of an adult. On the posterior part the mastoid process is totally corroded from the posterior wall of the external auditory meatus (*b*) up to the base of the process (*c*). In the center a strip of the outer bone table (*a*) is preserved, the tip (*x*), however, and the whole lower (*d*) and medial (*e*) surface of the tip, as well as the adjacent bone substance, are totally corroded. The tip itself has a large hole (*x*) leading into the interior of the mastoid.

Fig. 504 shows the internal surface of the petrous bone evenly and deeply corroded from the base (*f*) along the anterior surface to the hiatus Fallopii (*g*). The corroded part extends on the anterior surface to the medial side of the eminence of the superior semicircular canal (*h*), to the middle of the sigmoid groove (*i*), backward almost to the meatus audit. int. (*n*). Laterally the sigmoid groove is deeply and coarsely corroded (*k*), and fistulous passages lead through the decayed bone into the digastric fossa (Fig. 504). The tegmen tympani (*t*) et mastoidei (*m*) is corroded in its full extent. On the whole the mastoid process is totally decayed and the petrous bone in its entire lateral half.

It is a wonder that people can live when the caries has produced such ravages. A greater wonder it is that we can operate on such people in such a state, preserve their lives, and stamp out the destructive disease. In a child I operated on more than twenty years ago, the whole mastoid was destroyed, the place was occupied by crumbling pieces of bone and exuberant lardaceous granulations. I removed the whole decaying mass of morbid overgrowth. The dura lay extensively bare. The operation seemed to be an ante-mortem autopsy, yet the child recovered. Ten months ago I removed carious and necrosed bone from the mastoid and petrous bone of a child, which

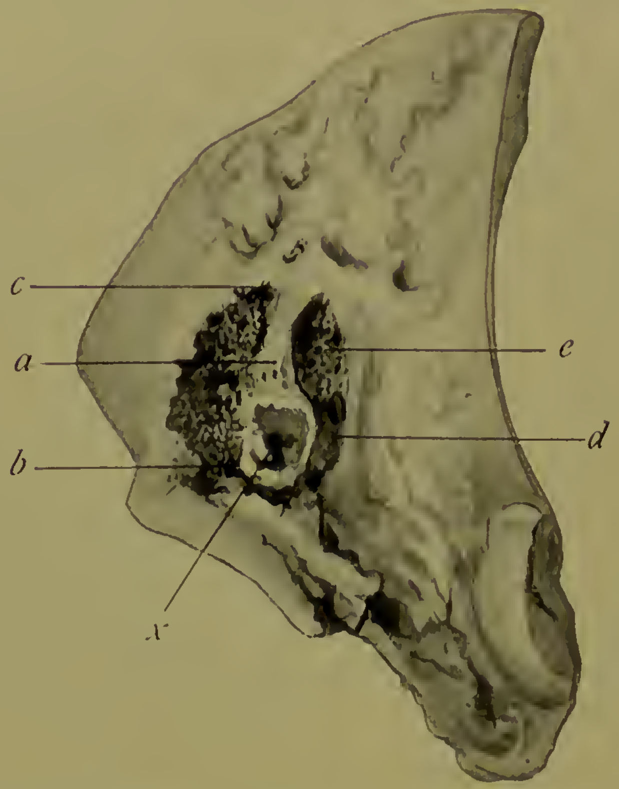

FIG. 503.—Caries of the mastoid and lateral half of the petrous bone of an adult (life size): Outer surface showing *a*, part of the outer table, preserved; *b*, posterior wall of external meatus; *c*, base; *d*, lower wall; *e*, medial wall; and *x*, tip of the honeycombed mastoid process.

in the living presented all the symptoms exhibited by the specimen depicted above; and, although tuberculosis was at the bottom of the affection, the child was perfectly cured. The tolerance by the organism of such deep and extensive ravages cannot be depended on, however, and these destructive processes are the chief causes of the disastrous intracranial complications of ear disease which we shall now discuss.

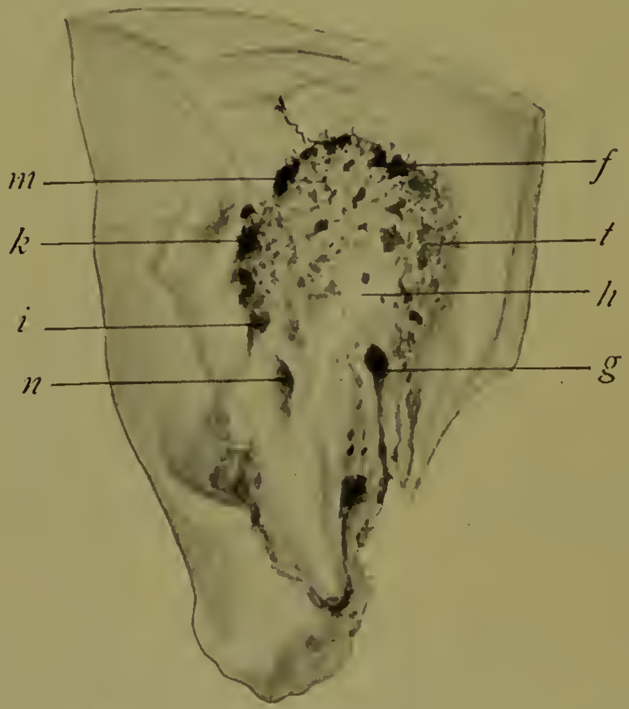

FIG. 504.—Inner aspect of specimen shown in Fig. 503, showing *b*, base of pyramid; *g*, hiatus Fallopii; *h*, eminence of superior semicircular canal; *i*, sigmoid groove; *k*, deep holes in corroded bone; *t*, tegmen tympani; *m*, tegmen mastoidei.

INTRACRANIAL COMPLICATIONS OF PURULENT OTITIS MEDIA.

Etiology.—The intracranial complications of ear disease are almost exclusively produced by the propagation of purulent inflammation of the different parts of the middle ear.

Occurrence.—They are met with in only a small percentage of ear diseases, but are most dangerous. According to Bürkner,[1] who found 104 deaths in 33,107 ear cases, as well as according to Randall,[2] who found 15 in 5000, three-tenths of one per cent. of all the ear patients die from otitic intracranial disease. Schwartze[3] found in the Prussian army 30 deaths in 8425 diseases of the middle and inner ear—*i. e.* 0.35 per cent.

The death-rate from purulent ear disease, compared with the death-rate from all diseases treated in a large general hospital, has been ascertained by N. Pitt,[4] who found among 9000 successive autopsies in Guy's Hospital (London) during the years 1869–1888, 57 deaths from purulent ear disease, which is 1 out of 158, or very nearly $\frac{2}{3}$ of 1 per cent.

Prof. J. Gruber[5] examined the *post-mortem* records of the Vienna General Hospital and found 232 deaths from otitic intracranial disease among 40,073 autopsies—*i. e.* 0.58 per cent.

Propagation.—In the great majority of the cases ear disease extends into the brain through destructive inflammation of the bone (Fig. 505), by which infective material enters the cranial cavity, accumulates between bone and dura, and causes pachymeningitis, leptomeningitis, sinus thrombosis, cerebral and cerebellar abscess. The infective material may, though rarely, be conveyed into the skull by offshoots of the dura mater, the aqueducts (Fig. 506), and the canals through which blood-vessels, lymphatics, and nerves pass from the tympanic into the cranial cavity.

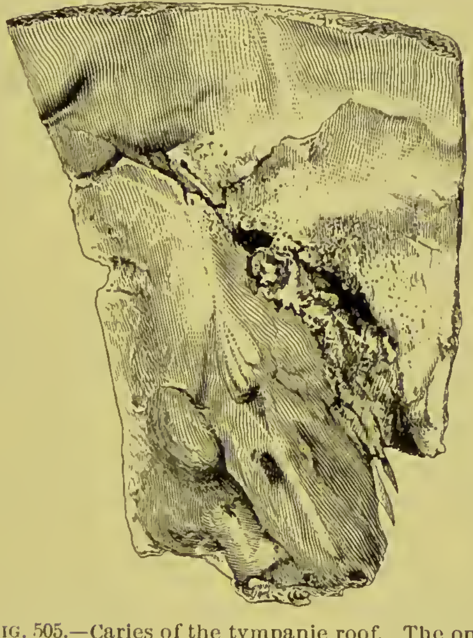

FIG. 505.—Caries of the tympanic roof. The openings were sealed by the thickened dura and the brain was not here involved. Death by basal meningitis from infection through internal meatus.

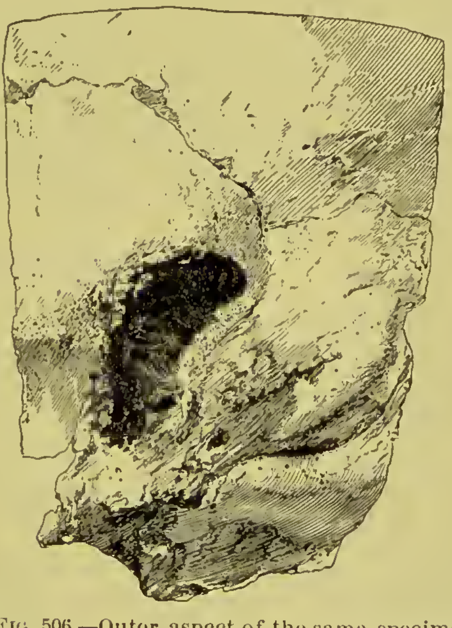

FIG. 506.—Outer aspect of the same specimen, showing loss of the back wall of the canal and openings into the facial and semicircular canals above the empty oval window.

The infective material consists of the different species of pyogenic micro-organisms—staphylococcus pyogenes, streptococcus, pneumococcus, and others, the same that cause the primary ear disease—and their products, the toxins.

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[1] *Arch. f. Ohrenh.*, xx. p. 81.

[2] *Trans. Am. Otol. Soc.*, v. p. 101.

[3] *Arch. f. Ohrenh.*, xxi. p. 221.

[4] *Brit. Med. Journ.*, 1890, vol. i. pp. 643, 771, 827

[5] *Arch. of Otol.*, xxv. p. 401, 1896.

Causes.—Generally only the severer forms of otitis media are complicated with brain disease, such forms as are caused either by certain acute general diseases—scarlet fever, diphtheria, influenza, measles, variola, and typhoid—or by some chronic, debilitating, constitutional affections—tuberculosis, diabetes, syphilis. Sometimes grave cases of purulent otitis, terminating fatally by brain complications, are caused by accidental atmospheric, chemical, and mechanical influences; for instance, blizzards, sea-bathing, foreign bodies in the ear, rough and unclean methods in removing foreign bodies and diseased deposits from the ear, forcible syringing in acute suppuration, all devices and remedies tending to pen up secretions, such as tampons and coagulating powders, morbid formations in the middle ear and auditory canal—*e. g.* polypi, sequestra, exostoses, cutaneous membranes, cystic and other tumors.

Acute purulent otitis leads more rarely to intracranial complications than *chronic;* yet by no means so exceptionally as was formerly believed.

Passageways of Infection.—The channel of invasion of the skull cavity most frequently passes through the medial and superior walls of the *mastoid* into the posterior cranial fossa; next in frequency it passes through the *tegmen tympani* into the middle cranial fossa, then through the *medial wall* of the drum by way of the labyrinth and the internal-ear canal, or directly through the posterior wall of the petrous bone into the posterior cranial fossa; rarely through the lower and *anterior walls* upward along the fossa for the bulb of the jugular vein or the carotid canal. Exceptionally the infective material travels through the tympanic ostium of the Eustachian tube or the semicanal for the tensor tympani muscle forward and inward, forms a retro-pharyngeal abscess, and penetrates through one of the crevices at the base of the skull into the cranial cavity, as in a case of Tröltsch[1] and another of the present writer.[2]

INFLAMMATION OF THE MENINGES.

Meningitis in general may result from a constitutional infective disease, such as tuberculosis or syphilis, or it may originate in a neighboring structure, from a wound of the skull, or, what concerns us here, a diseased—*i. e.* suppurating ear. We may distinguish pachymeningitis from leptomeningitis.

Pachymeningitis may be external, the common kind, or internal.

Pachymeningitis Externa; Epidural or Extradural Abscess.—The infection may be carried

(*a*) Through vascular and membranous canals from the inflamed tympanic cavity through healthy bone into the cranial cavity, which is very rare; (*b*) through a fine, fistulous canal, not always macroscopically discoverable, through apparently healthy bone; or, the most frequent condition and (*c*) through bone broken down by caries, necrosis, or erosion and atrophy from cholesteatoma and tumors. Jansen[3] describes a peculiar channel—namely, through the labyrinth and the *aqueductus vestibuli* to the posterior surface of the petrous bone with formation of an empyema in the endolymphatic sac.

As pachymeningitis externa leads to thrombophlebitis and abscess, the reverse course may occur; thrombophlebitis and abscess may induce pachymeningitis and leptomeningitis, which then commonly prove fatal in a short time.

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[1] *Arch. f. Ohrenh.*, iv. p. 121, Fall 6.

[2] *Arch. of Otol.*, xxiv. p. 125, 1895.

[3] *Berl. klin. Woch.*, 1891, No. 49.

Pathology.—When we expose the dura in cases of acute purulent otitis media we usually find it either normal or slightly reddened and dull; in more advanced inflammation it is vascular, thickened, and beset with granulations. In chronic cases, with circumscribed caries or necrosis of the underlying bone, it is blackish like the bone, softened, gangrenous, and perforated, bathed in serum. In purulent destruction of the bone it is separated from the latter by pus which has the characteristics of the pus in the middle ear, creamy and sweet in the acute, thin, greenish, and offensive in the chronic, cases. In a very chronic course the dura may be greatly thickened and fibrous or sarcomatous looking. Zaufal[1] describes a case in which the dura was 1.5 cm. thick; and the writer has seen a similar case where chronic empyema of the sphenoidal and ethmoidal sinuses showed perforation of the optic groove at the sella turcica and the greatly thickened fleshy dura looked like a flat sarcoma, but gradually thinned down and was attached to the healthy neighboring bone. The pus between dura and bone does not collect in a circumscribed cavity, but spreads in different directions, following readily the sigmoid sulcus into the jugular foramen, and up along the transverse sulcus toward the *torcular Herophili*, also at the bend of the sinus into the middle cranial fossa.

Epidural abscess may be recovered from by a spontaneous opening into the ear through the medial wall of the mastoid, the roof of the tympanum, the squama temporalis, or through the occipital bone above and behind the ear canal. The writer has seen spontaneous perforation of the occipital bone 4 or 5 cm. behind and about 1 cm. above the ear canal in two cases. He opened the subperiosteal abscess, and could introduce a probe through the bone fistula into the posterior cranial fossa. One case made a spontaneous recovery,[2] and has been under observation these three years; the other died from sinus thrombosis and leptomeningitis fifteen years ago. The autopsy showed[3] that the bone fistula was about in the middle of the transverse sulcus. In the great majority of cases of epidural abscess the dura perforates and the patient dies from consecutive cerebral abscess or purulent sinus thrombosis and leptomeningitis. All these grave affections may occur together in one case.[4]

Diagnosis.—In most cases the presence of an epidural abscess is ascertained only during the operation, when the broken-up medial wall of the mastoid or a fistula either in this wall, in the roof of the drum and mastoid or in some other part of the skull leads into the collection of pus. In many cases symptoms of meningeal irritation are present—namely, headache, slight rise of temperature, pressure-pain, somnolence, slowing of pulse, vomiting, stiffness of the neck, choked optic disk; but these symptoms are too indefinite to make a diagnosis. If after the opening of a subperiosteal abscess a probe can be passed through a bone fistula into the cranium, we may be assured of the presence of an epidural collection of pus. In a number of cases, however, doughy swelling and tenderness on pressure about one inch behind the ear canal, the place of exit of the mastoid emissory vein, and the history and other symptoms make a cranial complication probable, and we may fairly suppose that we have to deal with an epidural abscess.

Prognosis.—If we know that, with the few exceptions of a spontaneous perforation, epidural abscess is always fatal, the *indication* of operative interference is imperative. As in the majority of cases the diagnosis is uncertain, the operation should be begun in an exploratory way, and desisted from or continued and terminated according to the conditions revealed. When operated on, almost all cases recover.

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[1] *Prager Med. Woch.*, 1893, No. 50.

[2] *Arch. of Otol.*, xii. p. 155, 1893.

[3] *Arch. of Otol.*, xii. p. 44, 1883.

[4] *Arch. of Otol.*, vol. xxi. p. 239, 1892.

Pachymeningitis interna (*subdural, or intradural abscess*) is not often met with. When in a circumscribed place the externally inflamed dura is corroded, softened, and perforated, exudation is deposited on its inner side in the subdural space. If during this process the arachnoid and pia are agglutinated to the dura, pus may accumulate in this place and form a subdural abscess, with softening and ulceration of the adjacent brain-substance—circumscribed encephalitis. W. Macewen, in his classical treatise on the "Infective Diseases of the Brain and Spinal Cord," described several cases of this variety, one of which (Case X., p. 75) was cured by an operation.[1] If, on the other hand, this agglutination does not occur, the infective exudation spreads in the subdural space and leads to

Purulent Leptomeningitis.—The pathogenic substances may be carried into the arachnoid space in various ways—(*a*) after perforation of the dura, as we have seen, or (*b*) without perceptible perforation. Leptomeningitis is developed chiefly in the neighborhood of the diseased dura, on the base of the brain, travelling thence to the convexity of the same side, and to the base and convexity of the other. In rare cases the convexity only shows macroscopic changes, whereas the base appears healthy, as it was in the case described and depicted by the writer in the *Archives of Otology*, 1895, p. 125. The pus is collected in the furrows between the convolutions and also in disseminate patches. The pia is hyperemic and edematous. In addition to the purulent meningitis we frequently find the tubercular kind; and lately attention has been called by Quincke, Levi, and others to *serous meningitis*.

Meningitis purulenta may be *general* or *partial* (circumscribed). It has been found oftener on the right side than on the left (Körner).

Etiology.—Meningitis may be induced as well by acute as by chronic purulent otitis, with or without caries. It may be uncomplicated or accompanied and caused by sinus thrombosis and cerebral abscess. Otitis in tubercular and syphilitic subjects leads more readily to meningitis than otitis in healthy subjects. It rarely occurs in small children, which is remarkable. The author has operated on children between one and four years old where the greatest ravages—caries and necrosis—destroyed the mastoid and petrous and laid the dura bare to a very large extent; yet the children had no symptom of leptomeningitis and recovered.

Duration.—Otitic meningitis may be *acute*—in exceptional cases fulminating, setting in almost suddenly and terminating fatally in four or five hours or in several days—or *chronic*, with mild symptoms and intermissions at first, then developing into the regular course, which usually lasts one week or less, more rarely two or three weeks.

Symptoms.—*Headache* is, as a rule, the earliest and most pronounced symptom. At first it is parietal, occipital, or frontal, and on the same side, later general.

Dizziness, restlessness, irritability, auditory and visual hyperesthesia, mental weakness, loss of appetite, constipation, drowsiness without regular sleep, nausea, vomiting, optic neuritis (rare), more or less constant acceleration of pulse and elevation of temperature, delirium, convulsions, and coma are the chief symptoms of the regular course. They may be modified by complication with abscess (temperature high, pulse slow) and septic sinus thrombosis (rapid diurnal changes of temperature).

Prognosis.—Purulent meningitis due to ear disease, like that due to other causes, terminates fatally in the great majority of cases. How numerous in well-established diagnosis the exceptions are must be left to future observations in brain surgery to decide. The cases of *diffuse* purulent meningitis thus far reported as cured by operation do not stand criticism; whereas *partial* meningitis, epidural and subdural abscess, and the serous meningitis, which shows a majority of the symptoms of diffuse meningitis, have undoubtedly been cured by operation, and some have recovered spontaneously.

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[1] See a good case by Jas. F. McKennon, *Arch. of Otol.*, June, 1898.

Sinus Thrombosis and Pyemia.—Pathology, Course, and Termination.—The destruction of mucous membrane and bone-tissue in the middle ear and mastoid process by way of pachymeningitis, epidural abscess, and phlebitis frequently induces sinus thrombosis. If the thrombus is parietal and *uninfected* it causes no appreciable disturbance of the patient's health; if, however, it becomes contaminated with pyogenic matter through perviousness of the vessel-wall by erosion, softening, and perforation, the thrombus becomes septic, decays, and causes pyemia. The lateral sinus is the one most exposed, but small bone veins may carry the infective material into the sinuses from different parts of the temporal bone. The thrombus may be partial or total (occlusive), uninfected or septic, single or multiple, limited to one sinus, or extending over almost all sinuses and veins of both cerebral and cerebellar hemispheres. The lateral sinus is more frequently thrombosed than any other, particularly its sigmoid segment; then the inferior and superior petrosals, the cavernous sinus, the bulb and the whole length of the internal jugular.

Non-infected thrombi may disappear by absorption, or may by a kind of "organization" obliterate the vessel and do no harm. *Infected thrombi* may in rare cases, by destruction of the sinus-wall, be evacuated through a fistula of the destroyed bone, without causing disastrous consequences. Not quite so rarely they are carried by the blood-current into distant organs, especially the lungs, and produce larger and smaller metastatic abscesses and pyemia. Even in such cases recovery by and even without surgical interference is possible. In the majority of cases, however, if the affected sinus is not operated on, septic sinus thrombosis proves fatal by metastatic abscesses, pyemia, cerebral or cerebellar abscess, and purulent meningitis.

Sinus thrombosis is more frequent in men than in women, and more frequent on the right than on the left side. It occurs more rarely in acute than in chronic cases, and the predisposition to it is greatest in the second and third decades of life.

Symptoms.—Arranged according to their frequency and importance we note: (1) *Headache.*—It corresponds more or less to the situation of the thrombus, usually 2 or 3 cm. behind the upper edge of the external ear canal, over the knee of the lateral sinus where infective otitic thrombosis most often begins. It may, however, radiate over the parietal region of the head or be marked in the occiput, rarely in the forehead of the same side. The headache may be most intense, depriving the patient of all sleep during twenty-four hours.

(2) *Acceleration and weakness of the pulse,* more or less constant.

(3) *Rapid changes of temperature,* running from near the normal up to 104°–106° F. in several hours, and falling again to the original level the same day—the characteristic steep-peaked temperature chart of pyemia. See the accompanying chart (Fig. 507), taken from a recent publication of Fred. Whiting of New York: "Three Successfully Operated Cases of Pyemic Sinus Thrombosis."[1]

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[1] *Arch. of Otol.*, xxvii. p. 26, 1898.

(4) *Rigors.*—Quotidian or tertian chills lasting half an hour or longer, followed by profuse perspiration.

(5) *Swelling and tenderness over and behind the posterior edge of the mastoid* (sigmoid sinus thrombosis); further back, half-way between the ear and the occipital protuberance (transverse sinus); in the depth and around the orbit with protrusion of the eyeball (cavernous sinus); below the tip of the mastoid and down the anterior border of the sterno-cleido-mastoid muscle (bulb and internal jugular vein, which in its upper portion and sometimes in its whole extent is felt as a hard and tender cord.

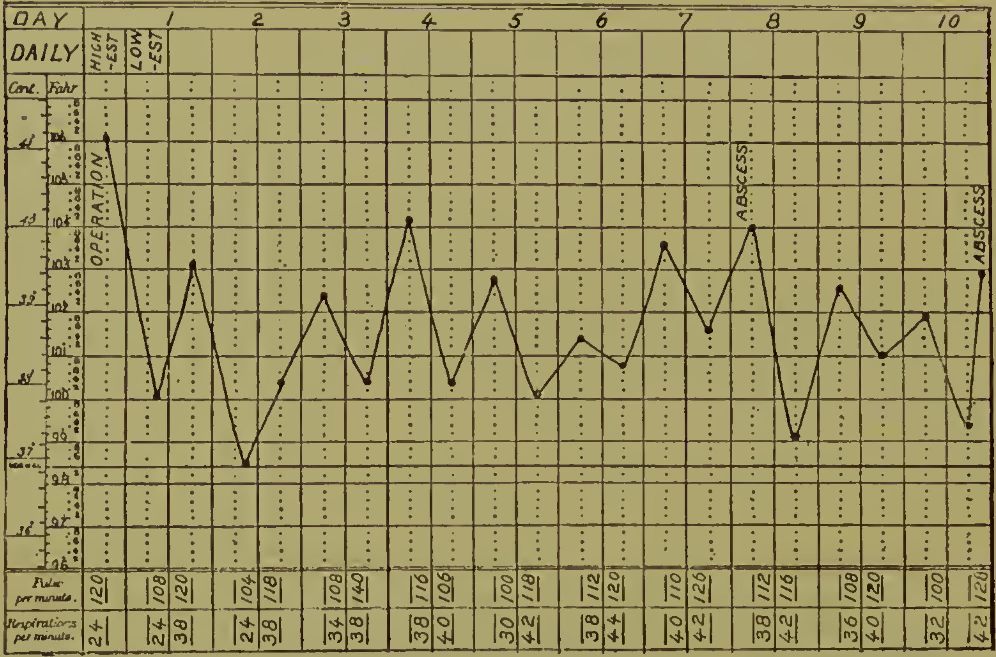

FIG. 507.—Typical chart of pyemic sinus-thrombosis in one of three successfully operated cases (Whiting).

(6) The *tongue is dry and coated, and the appetite lost*, in marked cases to the refusal of all food.

(7) *Diarrhea* in most cases, *constipation* in some.

(8) *Comprehension* slow; stupor and optic neuritis only in complication with encephalic abscess and meningitis.

The **diagnosis** in uncomplicated infective sinus thrombosis is easy; in complicated cases (abscess and meningitis) the marked and characteristic symptoms (steep-peaked temperature curve and rigors) of pyemia overshadow those of abscess and meningitis, so that in complicated cases it is easier to recognize the presence or absence of thrombosis than that of abscess and meningitis.

The **prognosis** is bad if the disease is allowed to take its natural course; only a few well-established cases of spontaneous recovery are on record. The prognosis is much better since the advance of otology and surgery has led to the early recognition and the operative cure of this disease. The mortality even now is still considerable, and the records of well described cases at present at our disposal do not suffice reliably to express the percentage of mortality. The prognosis in any given case, short of deep coma, is not absolutely hopeless, since even patients with the severest cephalic symptoms and severe metastatic pneumonia have recovered.

Prof. O. Körner, in his exhaustive monograph: "The Otitic Affections of the Brain, the Meninges, and the Venous Sinuses," describes two additional varieties of pyemia:

Osteitic Pyemia with Sinus Phlebitis (Osteo-phlebitis of the Temporal Bone).—This disease is rare. It is caused by the entrance of pus from the primary focus in the ear or the temporal bone into the general circulation through small veins. The symptoms are like those of pyemia from sinus thrombosis. Its existence as distinct from the latter is doubted, but any one who has ever seen, like the writer, a fatal case of pyemia from osteo-myelitis of the thigh, will ask with Körner: Why should such a disease not originate in an acute inflammation of the mastoid? Rigors are not so frequent as in sinus thrombosis; metastases are rare in the lungs, but occur in the joints, muscles, and the subcutaneous connective-tissue, and the streptococcus has been found in them as the pathogenic germ. The prognosis is better than that of sinus phlebitis; and the treatment should be conducted according to general surgical principles; some cases in which the internal jugular was ligated have ended fatally (Lane, Deansley, Langenbuch).

Septic Affections from Suppuration of the Ear and Temporal Bone.—This variety is distinguished by a very rapid course (sometimes in a few days), severe cerebral symptoms, especially delirium, high continuous fever, septic endocarditis and nephritis, hemorrhages in the endocardium, the muscles, the retina, etc. Körner describes two cases of his own practice in which he dwells on the rapidly increasing edema in the region of the diseased bone and the infected cervical glands, while the sinuses and emissary veins were entirely intact. In a case under Fränkel's care, which ran its fatal course under the picture of a dermato-myositis, the tissue-juice and the muscles were filled with streptococci in pure culture. Körner says that this supports the supposition that these septic processes spread chiefly through the lymph-channels, not like the pyemic through the blood-vessels. The present writer cannot suppress his impression that the above observations might have been cases of primary otitis purulenta complicated with erysipelas.

Brain-abscess (Cerebral and Cerebellar).—This severe affection is induced in the great majority of the cases, not by disease of the mucous membrane, but "by disease of the bone which almost always extends to the dura mater. In 9 per cent. it has been caused by acute, in 91 per cent. by chronic otitis. The dura is almost always united to the surface of the brain at a point where the cerebral abscess is nearest to the diseased bone. The brain-substance which separates the abscess cavity from the place of union between dura and bone is, as a rule, only a few millimeters broad, and has almost always—in 84 out of 90 cases—been found diseased" (Körner).

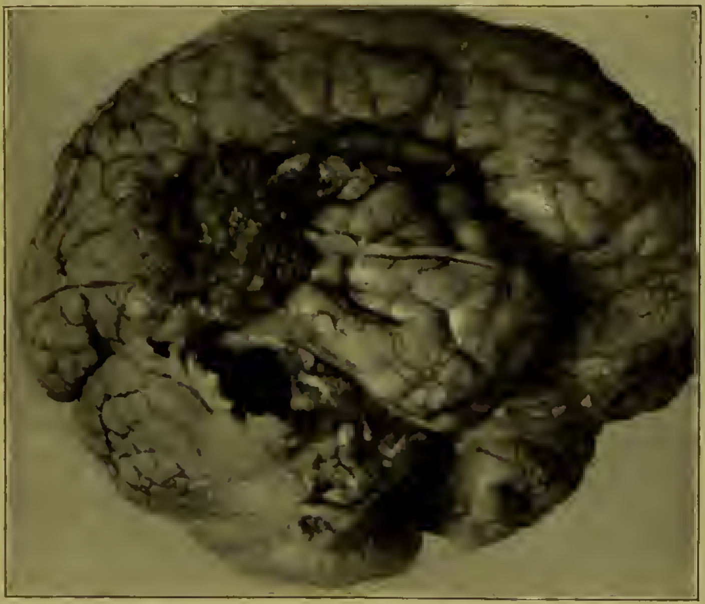

FIG. 508.—Right antero-inferior aspect of brain, showing cerebellar abscess and spheno-temporal hernia cerebri.

The abscesses are found in the neighborhood of the diseased bone, about 66 per cent. in the temporo-sphenoidal lobe, over the tegmen tympani et mastoidei, upon which the fusiform gyrus is situated; 30 per cent. in the cerebellum, near the sigmoid groove, where the anterior surface of the cerebellar hemisphere is situated (Fig. 508); the remaining 4 per cent. are found in the crura cerebelli ad pontem, the pons, or very rarely in the occipital or frontal lobes. In children, statistics show that 82 per cent. are in the cerebrum, 18 per cent. in the cerebellum; in advanced years we find 63 per cent. in the cerebrum, 37 per cent. in the cerebellum, all of which is explained by the development of the pneumatic spaces in the mastoid with advancing years.

In 15 per cent. more than one abscess has been found in the brain.

The size of the abscess varies from the smallest dimensions to the occupancy of almost the entire temporo-sphenoidal lobe. Among the largest is the one described and depicted by the writer in 1895.[1] It was 8 cm. long and 6 cm. high. They contain usually the same kind of pus as the otorrhea shows, thick and creamy or thin, frequently greenish and offensive. The majority being chronic are capsulated. The capsule has been found from 1 to 5 mm. in thickness. Those non-capsulated are commonly surrounded by a zone of softened brain-substance, which easily ruptures when the brain is removed. Not only abscesses that are free from, but also most of those invested with, a capsule continue to grow nevertheless.

Abscesses may in their growth communicate with the mastoid or the middle ear and give off continuously some of their contents; they may also erode and perforate the cranial capsule and discharge pus through a fistula, as in the case of Schede, one of the earliest to be successfully operated on. Spontaneous evacuation through the ear has been noticed by Randall[2] (Fig. 509) and many others, yet it did not cure the abscess. A notable fact is that a constant otorrhea from central abscess often suddenly stops during the course of an operation without any significance as to the result. The only case of spontaneous recovery of a cerebral abscess on record is by Sutphen, of Newark, N. J., who found at the autopsy of a patient dead from arrosion of the carotid an old abscess which had emptied itself previously by a carious perforation of the temporal bone. The almost unexceptional termination of an encephalic abscess, if not operated on, is death, caused either by cerebral pressure and edema, by perforation into the ventricles or the subarachnoid space, or through complicating sinus thrombosis and meningitis.

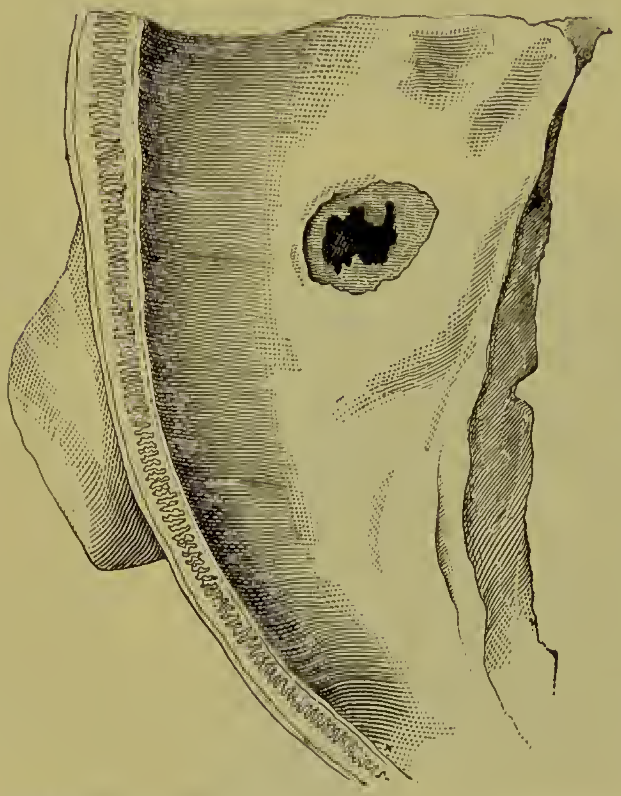

FIG. 509.—Caries of the tympanic roof, with ulceration through the dura, communicating with a large abscess in the overlying temporal lobe, emptying through the tympanum just before death.

Symptoms, Course, and Termination.—In many cases we may distinguish four stages: the *initial,* with fever, headache, vomiting, etc.; the *latent,* with milder discomfort; the *manifest,* with the full development of a severe brain disease; and the *terminal*, with exhaustion and coma, or sudden appearance of the fatal phenomena from perforation into the ventricular or arachnoid cavities.

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[1] *Arch. of Otol.,* xxiv. p. 121.

[2] *Trans. Amer. Otol. Soc.,* 1892.

According to v. Bergmann[1] three groups of symptoms may be distinguished—viz.:

1. *General Symptoms.*—Weakness, loss of appetite, foul tongue, pale or yellow color as in all grave diseases; fever moderate or absent.

2. *Cerebral and pressure symptoms*, generally more pronounced in cerebellar than in cerebral abscess.

Headache is the earliest, most conspicuous, and most constant symptom. It is usually in the neighborhood of the abscess, but not infrequently in other regions, particularly the occiput and forehead and all over the head.

Tenderness on percussion is frequently but by no means generally present. Macewen's symptom, that one ear applied to the vertex of the patient hears the percussion-sound stronger from the diseased than from the healthy side, is, as far as my experience goes, unreliable. *Nausea and vomiting* are almost always present, but not characteristic. *Dizziness and disturbance of equilibrium* are frequent.

Disturbance of the functions of the brain is a frequent and marked symptom. Slow comprehension, apathy, incoherence of ideas, weakness of memory; at night frequently great mental excitement, crying, restlessness, delirium, alternating with drowsiness, optic neuritis, earlier and more pronounced on the diseased side; convulsions; *elevation of temperature*, moderate, usually with evening exacerbations; pulse slow; respiration regular.

3. *Localizing Symptoms.*—*Deafness* in the *non-suppurating ear* has been observed several times, and is explained by the fact that the auditory center of the right ear is situated in the temporal lobe of the left side, and *vice versâ*. *Word-deafness*—mental or sensory deafness—*i. e.* the patient hears the word but does not understand it. *Amnesic aphasia, agraphia, anarythmia* are rare, and motor aphasia has not yet been noticed in uncomplicated brain-abscess. *Word-blindness*, dyslexia (Berlin), *letter-blindness*, and *"word-" without "letter-" blindness*,[2] conditions in which with normal vision the patients cannot understand written or printed language, are referred to the visual memory center situated in the angular and supramarginal gyri on the left side of the brain.

Crossed paresis, crossed clonic and tonic spasms, and convulsions, crossed facial paresis and crossed hemianesthesia, all due to a lesion of the internal capsule, are occasionally met with.

Homonymous hemianopsia has been recorded seven times. It would probably have been found oftener had it regularly been sought after. In a case of abscess of the temporo-sphenoidal lobe operated on by the author, December 11, 1893, it was one of the determining symptoms.[3] The abscess was found at the first exploratory puncture and the patient is now perfectly well, but the homonymous hemianopsia is permanent. This symptom is produced by a destruction of the optic tract, somewhere along the optic radiation between the region around the calcarine fissure and the optic chiasm. In cerebral abscess it refers chiefly to the optic radiation in its subcortical passage through the temporo-sphenoidal lobe.

Cerebellar ataxia and *vertigo* are due to lesions of the worm.

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[1] *Die chirurgische Behandlung der Hirnkrankheiten*, 2d edition, p. 40, 1889.

[2] See a case reported by J. Hinschelwood, *Lancet*, Feb. 12, 1898, and one of Optical Aphasia, a symptom of spheno-temporal abscess cured by operation, described by P. Manassee, *Arch. of Otol.*, April, 1898.

[3] *Arch. of Otol.*, vol. xxiii. p. 155, 1894.

Opisthotonos, partial or total paralysis of the motor communis oculi and the abducens nerves, conjugated deviation of the eyes in some cases toward the affected, in others toward the unaffected, side, and nystagmus, are rare and indefinite symptoms.

Differential Diagnosis of Purulent Mastoiditis and its Different Intracranial Complications.—In children it is often difficult to ascertain whether the mastoid is diseased alone or together with the intracranial structures. Meningeal irritation caused by congestion and edema is not rare, but difficult to distinguish from infective intracranial inflammation. The course will show; and if on account of the persistence of alarming symptoms an operation is decided on, the conditions exposed by the chisel will lead to the diagnosis.

In children and adults the most important helps in the diagnosis are the kind and seat of the original (ear) affection. Here also an exploratory operation will frequently be the decisive step. The diseases in the middle cranial fossa are induced by disease of the *tegmen tympani* and *tegmen tubæ.* (The author has seen purulent meningitis of the anterior and middle lobes imitating a brain-abscess from attic suppuration with extension to the pharynx by way of the semicanal of the tensor tympani muscle.) Disease of the cerebellum is produced chiefly by mastoid suppuration, rarely by disease of the petrous bone, in which case the infection is carried through the labyrinth and inner auditory meatus into the cerebellum. The latter variety can be recognized by the total deafness it produces in the affected ear.

The *diagnosis is difficult if tuberculosis, nephritis, diabetes, etc. are complicated with chronic otorrhea.* The author, in a case of supposed brain-abscess, decided to open the skull, but desisted when he found that the inner table of the mastoid was healthy. The patient died of tuberculous meningitis (autopsy).

If *cerebral disease* exists together with *suppuration in both ears,* it may be difficult to ascertain in which hemisphere the brain lesion is. Local pain, tenderness on percussion, and other local symptoms such as edema and redness over mastoid, etc., may help in making the diagnosis.

A *cerebral tumor* may coexist with purulent otitis media. The diagnosis will usually be possible. The tumor has a slow development, no fever, no rigors, almost always optic neuritis, and constant headache.

The diagnosis between *abscess and meningitis* is made by the high temperature and acceleration of the pulse, without remissions, and the irritability, general excitement, restlessness, and hyperesthesia of the organs of sense in meningitis, contrasted with the slow cerebration, apathy, and drowsiness in abscess. Slow pulse with meningitic temperature, etc., may indicate coexistent abscess (Randall).

Infective sinus thrombosis is characterized by mental depression, rigors, constipation, anorexia, apathy, and the steep-peaked pulse chart.

Two, three, or all the intracranial complications may be present in the same patient. The writer has had under observation a patient in whom the autopsy showed mastoid empyema, perforation of the lower mastoid wall and extension of the pus down the neck, epidural abscess in middle and posterior cranial fossæ, septic thrombosis of all the sinuses of both internal jugular and most of the cerebral veins, an abscess in the temporo-sphenoidal lobe, another in the cerebellum, and to render the morbid collection complete, diffuse purulent meningitis.[1]

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[1] Described in *Arch. of Otology,* vol. xxi. p. 239.

DISEASES OF THE SOUND-PERCEIVING APPARATUS.

By HENRY A. ALDERTON, M. D.,

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THE sound-perceiving apparatus consists of all those portions of the acoustic nerve-apparatus central to the peripheral nerve-cells in the labyrinth, but is usually considered to include all of the labyrinthine structures. About 10 per cent. of all aural cases show evidences of pathological changes in some part of this apparatus, or of functional disturbances of the same; some authors (Bürkner, Randall) make this percentage rather less. Middle age is the period of life relatively most free from such alterations.

Morphology.—Complete absence of the labyrinth (Michel, Schwartze) or of the auditory nerve (Michel) may exist congenitally, or there may be an arrest of development in these parts producing corresponding deformities. Arrested labyrinthine development rarely occurs; but when it does, the cochlea is the part most frequently affected (H. Mygind). Malformation of the osseous labyrinth has heretofore been found most frequently, but it is probably true that with further observations the membranous labyrinth (Figs. 510, 511) will be found to be the part most commonly malformed; in fact, it is possible for the arrest in development to be confined to it (A. Scheibe). The malformations, when congenital, are usually the same on both sides (Michel and Claudius), and may or may not be associated with similar changes in the sound-conducting apparatus. Should these defects be slight in character, the hearing ability may be very little, if at all, impaired,

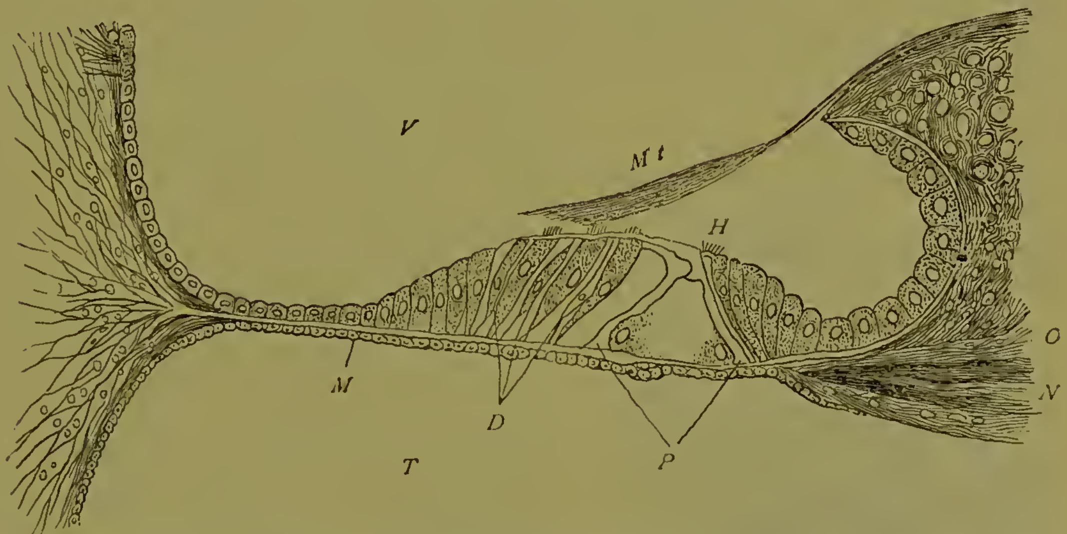

FIG. 510.—Section of normal Corti's organ: *M*, basilar membrane; *Mt*, tectorial membrane; *N*, fibers of cochlear nerve; *O*, osseous spiral lamina; *P*, pillars of Corti; *D*, Deiters's cells; *H*, hair cells.

as in a case of Voltolini's; but when the defects are more extensive, they are generally combined with great or total deafness (A. Politzer).

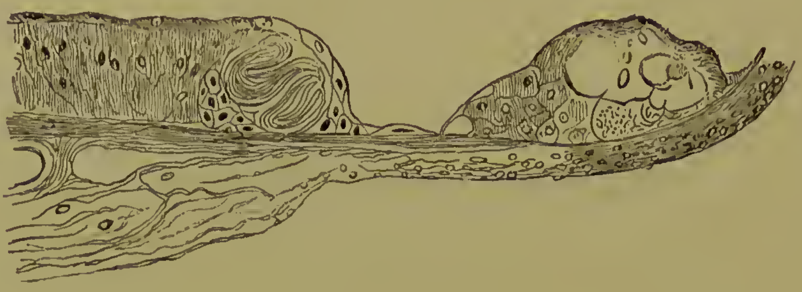

FIG. 511.—Section through the organ of Corti of a deaf-mute, showing arrest of development (Scheibe).

Pathology.—Of the circulatory disturbances occurring in the labyrinth, *oligemia or anemia*, if of limited duration, produces very little, if any, alteration in the anatomy of the part. It is possible that prolonged oligemia or anemia may give rise to degenerative changes (A. Politzer). *Hyperemia* of moderate intensity and duration is not likely to induce anatomical alterations, but, if long continued, may lead to increased pigmentary deposits (a moderate quantity of which, however, may be considered as not abnormal), to deposit of calcareous salts, to hypertrophy of the membranous labyrinth, to dilatation of the vascular structures, to serous saturation. If of great intensity, hyperemia may cause rupture of the vascular walls with consecutive hemorrhage. *Hemorrhages and ecchymoses* (Fig. 512) may occur in any part of the labyrinth, and there may have been no pre-existing hyperemia. Hemorrhagic extravasation may either be completely absorbed, become organized, undergo fibrous or calcareous degeneration, may cause atrophy and degeneration of the epithelium, connective tissue, and nerve elements, with an abundant formation of granular cells, hyaline corpuscles, and pigmentary deposits, or may induce inflammatory changes terminating in suppuration. *Emboli* may lodge in the labyrinth, as in Friedreich's case of embolus of the arteria auditiva interna, or infectious thrombi may form.

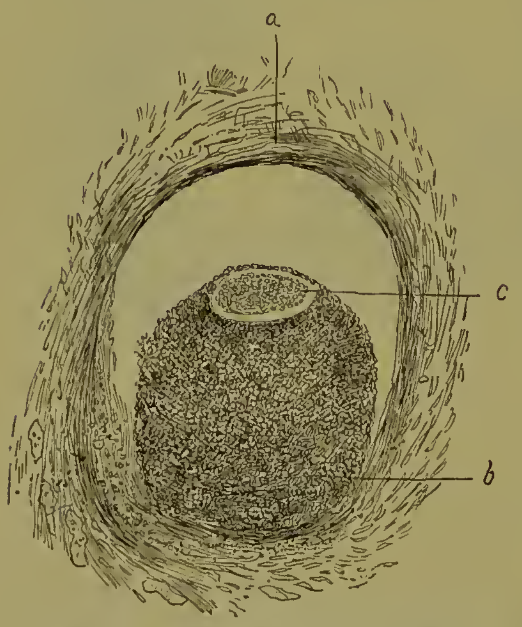

FIG. 512.—Hemorrhage into the semicircular canal (Politzer): *a*, section of the osseous semicircular canal; *b*, extravasated blood; *c*, membranous canal.

In regard to the inflammatory changes taking place in the labyrinth, the writer is inclined to believe that a classification according to the ideas expressed by Gruber is most reasonable and scientific, and would do much to dissipate the confusion now existing in most textbooks on the subject of diseases of the internal ear. *The inflammations affecting the labyrinth are, therefore, divided into:* (1) *hyperplastic* (*labyrinthitis hyperplastica*) *and* (2) *exudative* (*labyrinthitis exudativa*). In the former we may have hypertrophy of the auditory nerve stem, due to infiltration and proliferation of the neurilemma (Politzer); deposits of calcareous salts or of amyloid bodies in and about the nerve; hyperostosis of the petrous bone narrowing the labyrinthine cavities; thickening of the periosteum; increased quantity of the perilymph and endolymph (Steinbrügge); infiltration with small cells and hyperplasia of the connective tissue between the membranous and osseous labyrinth (Moos); a similar condition affecting the membranous labyrinth (Moos); development of osseous tissue from chronic inflammation of the labyrinthine periosteum; excessive epithelial growth on the inner side of the membranous labyrinth in chronic inflammation (Politzer); chronic endarteritis; depositions of concretions of phosphate of lime and of corpora amylacea within the labyrinth. *In the exudative form of inflammation* we have intense hyperemia which may produce a serous saturation of the structures of the labyrinth; an infiltration with small lymphoid cells (Moos) or round cells (Schwabach); a hemorrhagic exudation, as from a pachymeningitis hæmorrhagica (Moos); a purulent inflammation, due either to the direct propagation of pus from neighboring structures, or by way of the blood-vessels or by the lymph-spaces (Politzer), or by dehiscences in the bony wall between the superior semicircular canal and the cerebral cavity (J. Dunn), or to infection by the immigration of micro-organisms (Steinbrügge).

These inflammatory processes produce various alterations of the anatomical elements of the labyrinth: the effect of the invasion by micro-organisms is manifested by a mycotic fatty degeneration of the endothelium of the blood-vessels, causing coagulation and thrombosis and colloid degeneration of the labyrinthine tissues (Moos); injury of the acoustic nerve apparatus by hemorrhages or mycotic degeneration—the axis cylinders resisting longest (Moos); stasis and thrombosis of the periosteal blood-vessels (Steinbrügge); rapid destruction of the connective-tissue elements; destruction of the osseous tissue through entrance of the micro-organisms into the periosteum, the bone-corpuscles, and the blood-vessels of the Haversian canals. In addition, the poisonous products of metabolism, the toxalbumins, probably play an important part (Moos). The micro-organisms (streptococcus, staphylococcus and Fränkel's diplococcus of pneumonia (Schwabach) gain entrance to the labyrinth through the aqueducts, the periosteal blood-vessels and, probably, also along the sheath of the auditory nerve, as does the pus. In the beginning, the perilymphatic cavity is almost exclusively the seat of the disease, which later extends to the endolymphatic cavity (Habermann). The micro-organisms seem to collect and to develop their greatest working power in the most dependent parts of the labyrinth (Habermann). The inferior portions of the cochlea are, therefore, most affected (Politzer); Steinbrügge, however, thinks the proneness to location in this region is rather due to the propagation of the affection from the cranial cavity.

As a result of the inflammation of the labyrinth, the nerve fibers, cells, and ganglia (see Figs. 514, 519) are destroyed or atrophied from pressure, their place being taken by newly formed connective tissue, or left vacant, thus forming a system of lacunæ corresponding in arrangement to the normal nerve distribution of the part (Moos, Scheibe, Steinbrügge); the membranous labyrinth may be totally destroyed, likewise the structures of the labyrinthine windows, with displacement of the stapes (Habermann); coagulation necrosis of the labyrinthine ligaments may be produced, with consequent collapse of the membranous semicircular canals (Moos); the osseous capsule may be more or less destroyed. If the quantity or virulence of the infection be great, there may be absence of all tendency to reactive inflammation and the production of new formations (Moos).

Should reactive inflammation be established, it results in the production of newly formed granulation- (Habermann) (Fig. 513), connective (Moos, Scheibe), fibrous (Gradenigo), or osseous (Toynbee) tissue; these new formations at times going so far as to produce complete obliteration (Fig. 514) of the labyrinthine cavities (Politzer), of the foramina cribrosa, of the aqueducts (Scheibe), and of the oval and round windows (Toynbee). Ossification

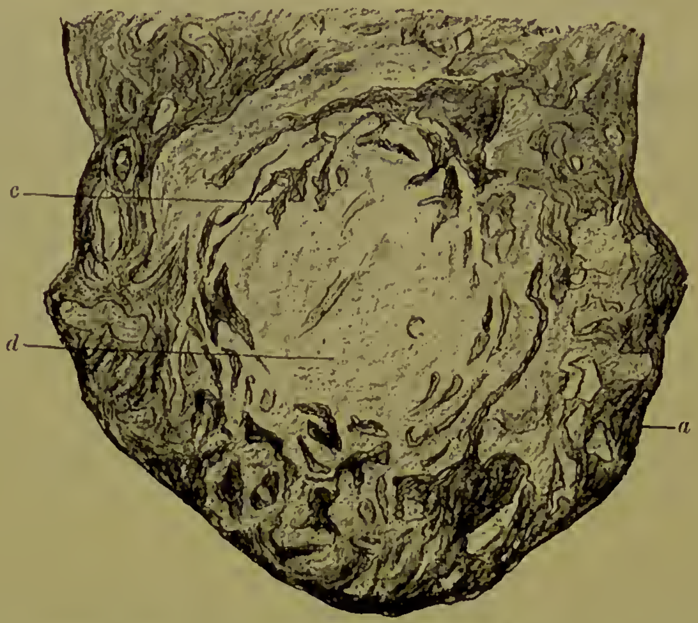

FIG. 513.—Section of semicircular canal of a boy dead from cerebro-spinal meningitis of seven weeks' duration (Habermann). Canal is filled with granulation-tissue (*d*), and in its periphery (*c*) the bone (*a*) is eroded.

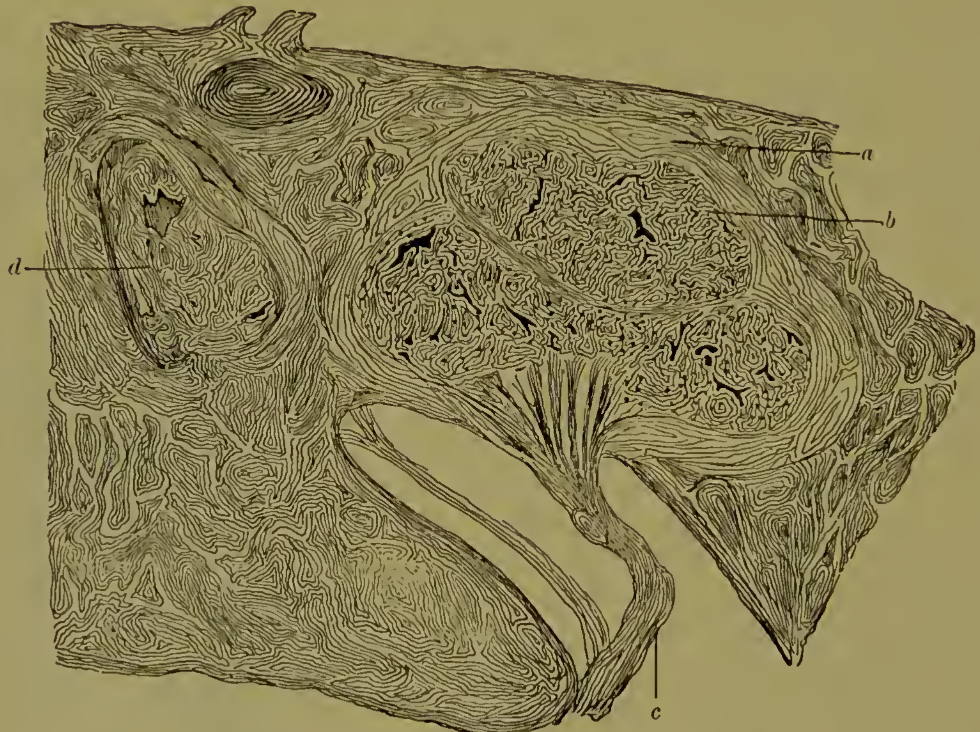

FIG. 514.—Section through the cochlea of a deaf-mute (Politzer): *a*, intact capsule; *b*, cavity of cochlea entirely filled with newly formed osseous tissue; *c*, auditory nerve, whose fibers continue only a short distance into the newly formed osseous mass; *d*, vestibule, narrowed by the hyperplastic process to a small angular space lined with roundish epithelial cells.

proceeds from the remnants of periosteum (Fig. 515) and from the newly formed connective and fibrous tissues.

Acoustic Nerve.—Among the pathological alterations of the acoustic nerve apparatus we will first take up changes in the stem of the auditory nerve. Hyperemia and ecchymosis may exist (Politzer); deposition of corpora amylacea or concretions of phosphate of lime; fatty degeneration (Politzer); gray degeneration (Wernicke); atrophy; leukemic small-celled infiltration (Alt); purulent infiltration (Heller); embedding of the nerve in meningeal exudation (Schwartze). Tumors, principally sarcoma, fibroma, and so-called neuroma, may invade the internal auditory canal (Fig. 516), exerting pressure with consecutive atrophy or even solution of continuity (Politzer). The auditory nerve is more frequently the seat of morbid growths than any other cerebral nerve (Virchow). The changes most likely to occur in the region of the acoustic nerve origin in the medulla are due to thickening and purulent inflammation of the ependyma of the fourth ventricle and softening of the floor (Knapp); effusion into the fourth ventricle, either serous (Stuart), aqueous (Jackson), sero-purulent (Armstrong and Clarke), or

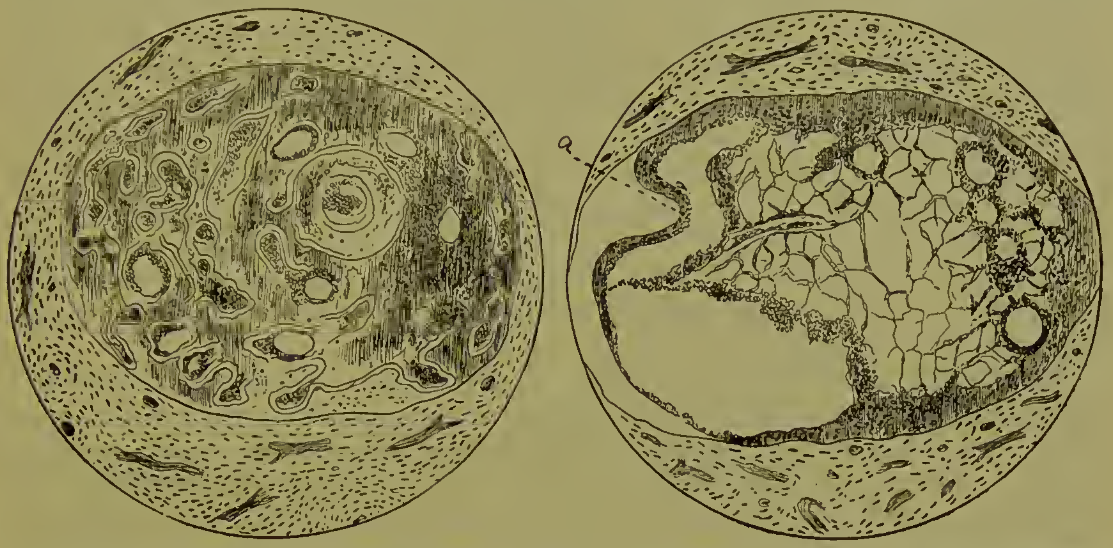

FIG. 515.—Sections of the semicircular canals of a boy dead of hydrocephalus internus (Steinbrügge). The canals are filled with connective and osseous tissue. The ossification is more advanced on the right at (*a*), beginning from detached periosteum.

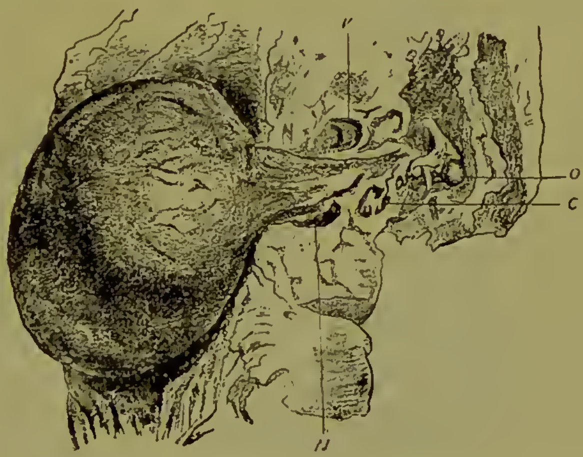

FIG. 516.—Spindle-celled sarcoma of the auditory nerve (Politzer); *O*, tympanic cavity with malleus and incus; *V*, vestibule; *C*, cochlea; *T*, tumor of the acoustic nerve; *N*, its extension into the auditory meatus.

purulent (Ames); tumors in or about the fourth ventricle. Disease of the first and second convolutions of the left temporal lobe also interfere with audition (Wernicke), the cortical center for hearing probably being located in this region. Of course, any pathological condition along the course of the cerebral acoustic nerve-fibers also induces disturbances of function. Increased intracranial pressure may cause secondarily increased labyrinthine pressure with depression of Reissner's membrane (Steinbrügge) and bulging outward of the membrane of the round window (Moos). Many cases, however, of increased intracranial pressure, as in chronic hydrocephalus, show no such change in labyrinthine pressure nor any impairment of the function of hearing (Pomeroy).

Etiology.—**Anemia** or oligemia of the labyrinth has been noted in connection with general anemia (Miot and Herck), with continued fevers (Roosa), with gestation and parturition (Pomeroy), with aneurism of the basilar and atheroma of the internal auditory artery (Miot and Herck), with changes in the middle ear exerting pressure upon the labyrinthine structures through the round and oval windows (Pomeroy).

Hyperemia of the labyrinth occurs in all conditions producing congestion of the head (Hartmann); in conditions exerting pressure on the venous channels of the brain and consequent obstruction to the return flow of blood from the ear (Politzer), on the vessels of the internal auditory canal (Politzer), or exerting pressure on the large veins of the neck (Schwartze); in disturbances of the circulation originating in the heart, lungs (Schwartze), or kidneys; in prolonged exposure to sharp sounds (Roosa); in the gouty or rheumatic diathesis. Any hyperemia of the labyrinth occurring in connection with inflammation of the external or middle ear must certainly be considered, since Eichler's recent anatomical confirmation of Schwartze's clinical observations, as the result of a reflex action through the sympathetic upon the vaso-motor nervous system of the labyrinth, rather than a direct influence through anastomoses. Eichler found that the vascular supply of the labyrinth was entirely distinct from that of the surrounding tissues, and that the connection between the vessels of the tympanum and those of the labyrinth, which Politzer maintains, does not exist. Schwartze had long ago held that even in the very highest degrees of inflammation of the tympanum it is only exceptionally that a simultaneous hyperemia is met with in the labyrinth. It is a matter of observation that in chronic middle-ear suppuration with granulomata and polypi the functional tests show no impairment of function of any importance in the sound-perceiving apparatus.

Hemorrhages and ecchymoses are prone to happen in all conditions producing hyperemia of the labyrinthine structures; in the infectious diseases causing changes in the vascular walls; in pachymeningitis hæmorrhagica (Moos); in leukemia (Steinbrügge); in typhoid fever (Barclay); in nephritis, gout, and rheumatism; in fracture or concussion of the skull; in diabetes; sometimes in embolism of the arteria auditiva interna (Gruber).

Atrophy and **degeneration** of the acoustic nerve apparatus may be caused by syphilis; by any labyrinthine inflammation of sufficient gravity to interfere with nutrition; by changes in chronic otitis media exerting long-continued pressure on the labyrinth and thus producing anemia, which, if continued for a sufficient time, will result in nutritive changes of the nature of atrophy (Pomeroy)—and these secondary nerve affections may remain although the tympanic disease disappears (Gruber); by acute hydrocephalus internus, leading to softening and shrivelling of the nuclei of the auditory nerve (Politzer); by fœtal ependymitis (Meyer) doing the same; in chronic hydrocephalus, tumors of the brain and the nerve from pressure (Politzer); gray degeneration and atrophy in tabes dorsalis (Pierrot, Wernicke, Habermann); in old age by calcareous deposits (Böttcher) and corpora amylacea (Politzer); by hemorrhage; by nephritis and influenza (Gradenigo); by contraction of the basilar artery (Politzer); by apoplectic and inflammatory processes involving the floor of the fourth ventricle (Politzer); by professional concussion of sound (Roosa); by purulent inflammation of the ependyma (Politzer); by purulent inflammation of the stem of the auditory nerve from a similar condition of the meninges (Politzer); by emboli and embolic softening along the acoustic nerve tracts (Politzer). Among the nerves of sense, the auditory is the most "impressionable"—that is, its function is more frequently impaired by general diseases and by chemical changes in the blood in infectious diseases (Politzer). Affections of the auditory nerve attack, in the majority of cases, both organs of hearing. It is probable that degenerative processes involving one auditory nerve will in time pass over to the other. The view that atrophy of the auditory nerve can take place purely from inaction, as in ankylosis of the stapes, has not yet been corroborated by experience (Politzer); in fact, the results of post-mortem examinations point the other way. The changes which occur in presbycusis and otitis media sclerosa seem to be due to a coincident trophic disturbance similar to that in the middle ear rather than to any atrophy from disuse (Alderton). Central atrophy depends almost without exception upon cerebral disease, whilst the peripheral is most often a consequence of disorders of the auditory organ itself (Gruber). The occurrence of the disturbances of hearing in these processes depends less upon the extent than upon the seat of the pathological accumulation (Politzer).

Hyperplastic inflammation (labyrinthitis hyperplastica) may occur in syphilis, which is causative in most of the forms of this affection; in the first stages of exudative inflammation of the labyrinth due to infectious diseases, and the inflammatory process may advance no further (Moos); in gout and rheumatism; in rachitis; in typhoid fever and leukemia and in old age.

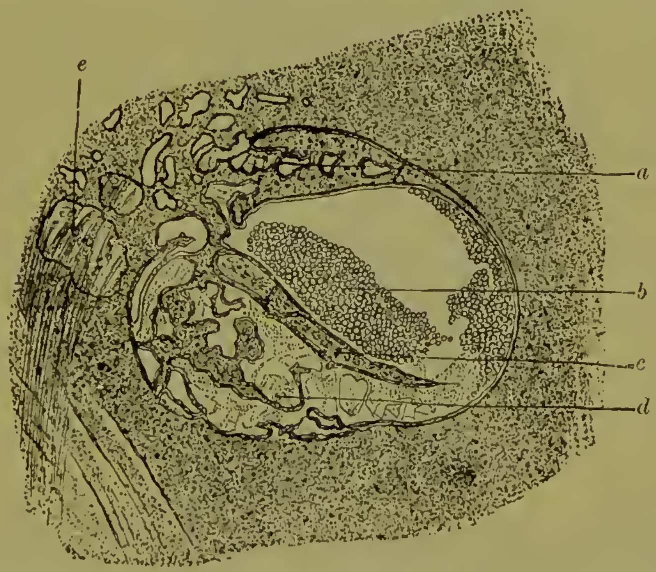

FIG. 517.—Section of the basal coil of the cochlea, from a deaf man who died of leukocythemia: *a*, osseous growth on the median wall of the scala tympani; *b*, leukocythemic plaques in the scala tympani; *c*, lamina spiralis; *d*, connective tissue and osseous growth in the scala vestibuli; *e*, atrophic ganglion-cells in Rosenthal's canal (Politzer).

Exudative inflammation (labyrinthitis exudativa) may be caused by obstruction in the internal auditory meatus to the outflow of blood from the labyrinth (Politzer); by typhoid fever (Barclay); leukemia (see Fig. 517) (Politzer); epidemic cerebro-spinal, hemorrhagic, pachy- and simple meningitis (Heller, Moos, Politzer); syphilis, tuberculosis, measles, diphtheria, scarlatina, scarlatinal diphtheria, mumps, variola; by an extension from an otitis media purulenta of long standing (Bezold). This form of inflammation occurs more frequently in children than in adults, because of the more frequent occurrence in children of the acute exanthemata, etc. Further, the anastomotic connections between the middle ear and the labyrinth on the one hand, and between the labyrinth and the cranial cavity on the other, are more numerous in children than in adults; and further, because in the child's ear through the aqueducts there is a freer communication between the labyrinthine fluid and the cerebro-spinal cavity than in the adult (Politzer).

Symptomatology.—Functional Reactions in General.—Before taking up the departures from the normal reactions to functional tests in diseases of the sound-perceiving apparatus it is necessary to devote some attention to the normal decline in hearing evidenced in advancing age. Zwaardemaker has tabulated the average responses for the upper-tone limit at the different periods of life about as follows:

Galton's whistle (see Fig. 472)	is heard under 10	years at the mark	1.22
" "	is heard from 20 to 30	" " "	1.39
" "	" " 40 to 50	" " "	2.23
" "	" over 60	" " "	3.03

A presbyecusis (hearing of old age) may, however, be considered as normal which is not lower than Galton 4.8 (Zwaardemaker). The lower-tone limit is elevated to about the same extent in old age (N. J. Cuperus). In old age the B.-C. (bone-conduction) does not alone experience a reduction, but sinks proportionately with the lessening of the hearing distance, the A.-C. (air-conduction), etc. (Bezold).

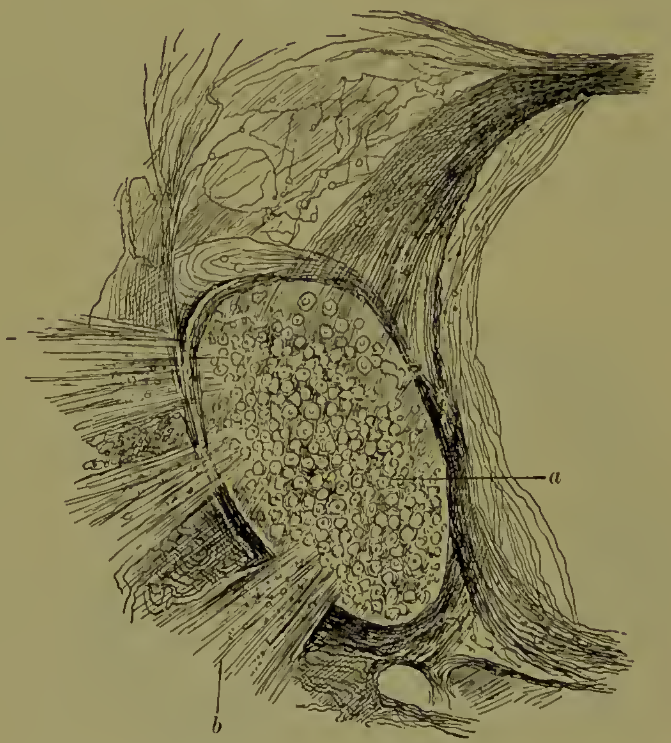

FIG. 518.—Section of Rosenthal's canal and the spiral ganglion (normal), showing—*a*, ganglion-cells in Rosenthal's canal; *b*, nerve-fibers of the cochlear branch entering into the ganglion (Politzer).

In diseases of the sound-perceiving apparatus, *the upper-tone limit*, obtained by means of the Galton whistle, *is lowered—i. e.* the highest notes elicited by the whistle being denoted by one or fractions of one, and the lower notes by multiples of one and their fractions; as the obturator is withdrawn the note deepens or lowers at the same time that the indicator or graduated scale shows higher and higher numbers, and, therefore, a higher number on the scale, as 4.8, indicates a much lower note than a lower number, as 1.22. *The lower-tone limit by A.-C.* (air-conduction), as obtained by a clamped tuning-fork vibrating from 26 to 64 double vibrations in the second, *is impaired very little or not at all. The absolute duration of B.-C.* (bone-conduction), Schwabach's test, *is shortened or abolished* for all or for certain tones. *A.-C.>B.-C.* (air-conduction is better than bone-conduction), *both in intensity and in duration* throughout the musical scale, Rinné's test. If the disease is unilateral, *the vibrating tuning-fork C*, placed *in contact with the vertex*, midway between the ears, *should be heard in the unaffected ear*, Weber's test; or in the better-hearing ear if the disease is bilateral. This test is not so reliable as those previously described. In labyrinthine disease the *patients hear the deeper tones of speech very well, while the higher tones are no longer perceived* (O. Wolf). It is well in testing with the whisper or speech to remember O. Wolf's division of the voice-sounds into—

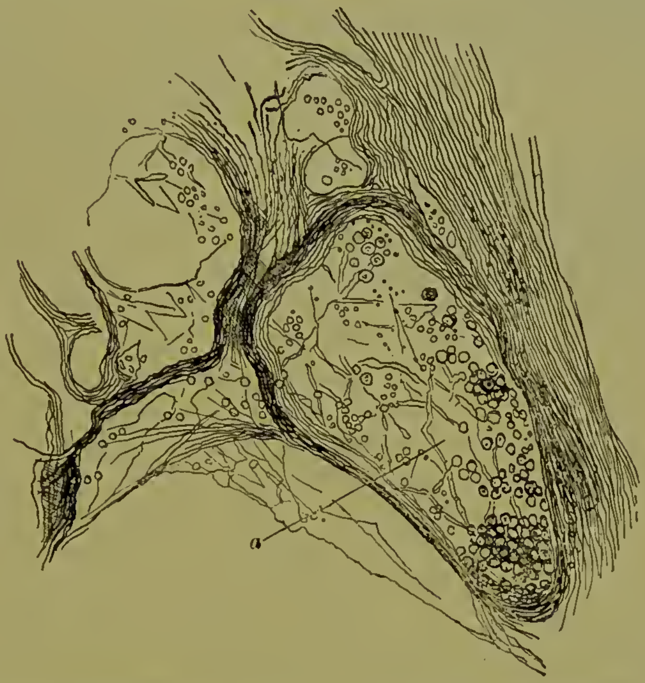

FIG. 519.—Section through Rosenthal's canal of a boy dead of acute encephalitis, who became suddenly deaf five years previously, showing marked atrophy of nerve-cells and fibers; *a*, Rosenthal's canal (Politzer).

1. The deep, like R and V;
2. The middle, like the explosives B, K, and T;
3. The high and strong, like S, Sh, and G; and the high and weak, like F, L, N, and H (which are excluded as dependent on other tones—tone-borrowing).

Wolf devotes particular attention to the consonants. Bezold employs the names of numbers as test-words, as these are familiar to both children and adults. Equal intensity of sound can be obtained by using the reserve air left after a forced inspiration followed by a normal expiration (J. E. Sheppard). To test the hearing for speech thoroughly, it is quite sufficient in most cases, after testing a few words, to note the distance for those words perceived with the greatest difficulty (Lucae).

Disturbances of equilibrium are apt to be observed in any process producing irritation of the nerve-endings in the vestibule, the semicircular canals, or in the stem and origin of the auditory nerve. In testing for disturbances of equilibrium, it is well first to determine the static (the body at rest) equilibrium and then the dynamic (the body in motion) equilibrium. The author tests the former by means of the apparatus shown in Plate 12, consisting essentially of a movable inclined plane, after the method of v. Stein. A person with normal powers of equilibrium should be able to maintain his erect position until the board reaches an inclination of 35° to 40° to the horizontal when facing toward the apex of the angle—anterior inclination. Posterior inclination, with the back turned toward the apex, varies from 20° to 30°; lateral inclination, with the side toward the apex, from 37° to 38°. In patients with labyrinthine disease, giving rise to vertigo, etc., the angle measures 20° or less by anterior inclination, etc., and this is much decreased when the eyes are closed. The static equilibrium is also tested with the eyes open and shut, with the legs close together, while standing on the toes, and while standing on one leg. A healthy person can stand in these positions for some time, with slight balancing, while the eyes are closed; but a person with imperfect powers of equilibrium immediately begins to show disturbances of these powers. The dynamic equilibrium is tested by walking forward and backward on a level, by turning on the vertical axis of the body to the right or left with legs together, and, finally, by turning about on one leg alone. The last movement is the most difficult, but a healthy person can go through these various motions with little if any trouble; whereas aural patients with disturbance of the powers of equilibrium find it more or less difficult or impossible, and their movements are attended by great weariness.

Given these reactions, the inference is well-founded that we have to do with an affection of the sound-perceiving apparatus. Still other tests have been devised by Bing, Brenner, Gradenigo, Gelle, and others; but the above have been more universally tried, are sufficient for the purposes of diagnosis, and are more reliable.

The symptoms of affections of the sound-perceiving apparatus are more particularly described as follows:

Anemia.—There is usually some dulness of hearing, which is manifested either as a slowness of perception only, or as a real impairment of the hearing power. The impairment in the hearing ability follows along the line of the test-responses as given above, especially, however, being noticeable in the curtailment of the duration of B.-C. Annoying tinnitus of a low pitch is commonly present. The patient may be subject to occasional attacks of vertigo, and usually is the victim of general anemia.

Hyperemia.—There is very little if any impairment of the hearing power, and there may be present hyperesthesia of the nerve to certain sounds. Often there is a feeling of fulness and distention in the ears or in the head, with dulness of intellect or even giddiness or vertigo at times. With this is usually associated a high-pitched tinnitus. The functional tests show a limited involvement of the sound-perceiving apparatus. Paresthesiæ are likely to be complained of.

Hemorrhage is usually immediately followed by marked vertigo, aggravated on closure of the eyes, with possible falling or unconsciousness (the

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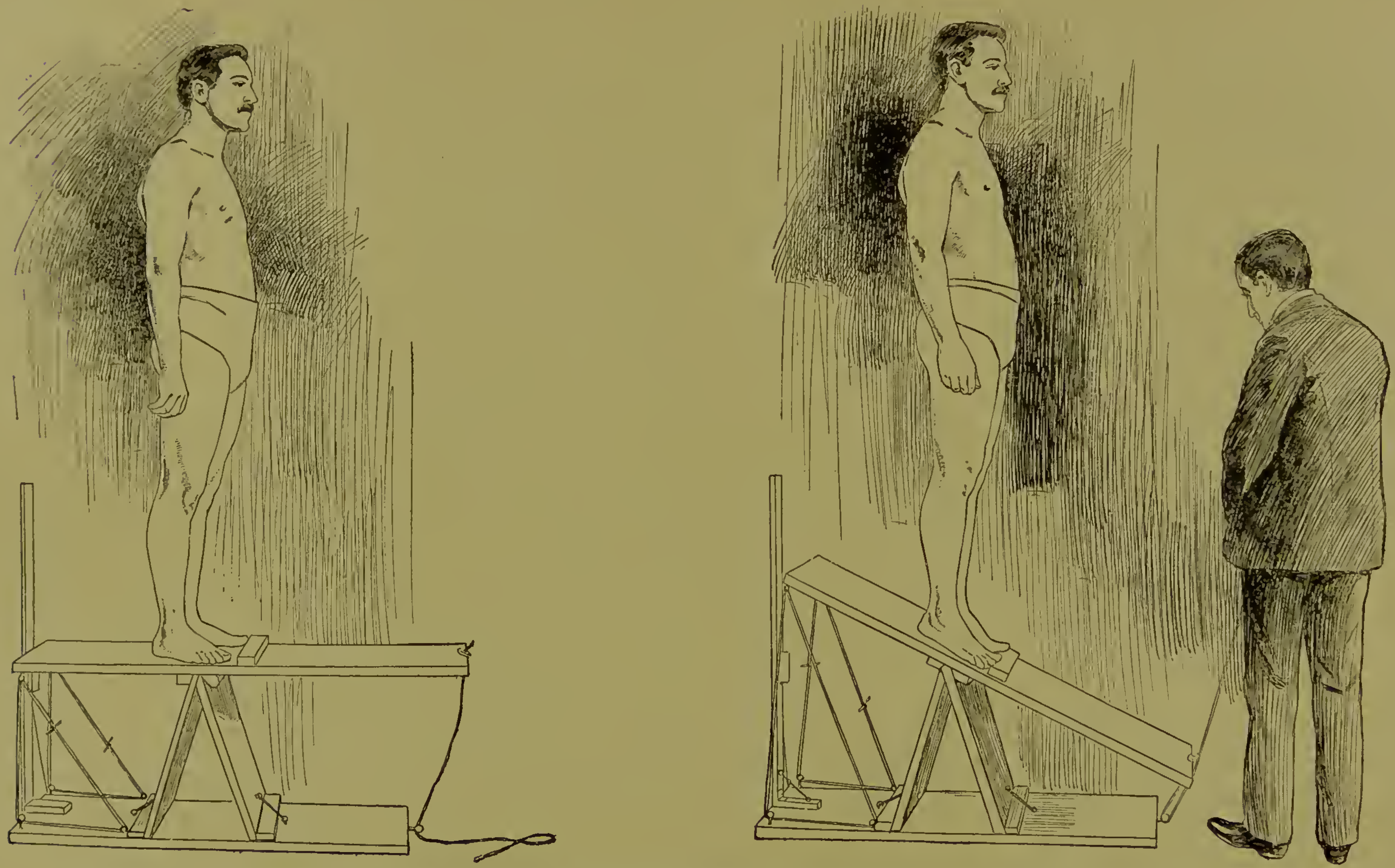
PLATE 12.



The author's static goniometer, consisting of a plane acting on the principle of a lever, the fulcrum being in the middle. The resistance at one end is obtained by solid rubber cords passing through pulleys, and the power at the other end by traction on a cotton cord passing through a pulley on the base-board. An upright at the resistance end is graduated in degrees corresponding to the angle that the inclined board makes with the base-board. The apparatus is made so as to be easily taken apart and stowed in small compass. A toe-rest to prevent slipping of the feet on the smooth board is placed just so far in front of the fulcrum as to bring the center of gravity of the patient about 2 to 3 inches behind the fulcrum. The apparatus is made of common pine boarding.

latter is rather rare) unless the hemorrhage is confined to the cochlea, in which case vertigo is absent (Gradenigo). With or immediately following this occur nausea or vomiting, severe tinnitus (in some cases preceding the attack), occasionally profuse perspiration, and impairment of the hearing up to complete deafness. The symptoms thus given constitute what was formerly generally designated as Ménière's disease, and is the only condition to which that name should be given. Amelioration of these symptoms takes place in a short time, the vertigo, hardness of hearing, and tinnitus continuing longest. The hardness of hearing rarely disappears entirely, and the tinnitus is likely to persist, although diminished in intensity. There is always danger of a repetition of the hemorrhage. The functional tests give varying responses according to the locality and the extent of the hemorrhage, but always confirm a diagnosis of involvement of the sound-perceiving apparatus.

The symptoms of embolism and thrombosis are presumably similar to those of hemorrhage, and serous effusion can give the same more fleetingly (Gruber).

Labyrinthitis Hyperplastica.—The most marked form of this inflammation is seen in connection with syphilis, usually as a late manifestation in the acquired, or around puberty in the hereditary, and gives rise to deafness, appearing gradually or suddenly, subject to periods of quiescence and exacerbation; also to loud aural tinnitus. Vertiginous attacks and disturbances of equilibrium are usually slight unless the exudative form of inflammation is induced. It is likely to be accompanied by very violent headache (Charazac), often nocturnal (Pomeroy) when due to syphilis. Both ears are usually affected. The sudden deafness coming on with serous saturation or lymphoid infiltration may disappear almost completely; but usually the hyperplastic formations are causative of a certain amount of permanent deafness. The functional tests leave no doubt as to the seat of the trouble in the sound-perceiving apparatus.

Labyrinthitis exudativa in its most acute form comes on very suddenly with perhaps a rigor; with fever, nausea, or vomiting very commonly; with profound deafness, marked derangement of co-ordination; at times, stupor or delirium (although usually the mind is clear); intense tinnitus and vertigo, and, in some cases, pain. This very acute form occurs with epidemic cerebrospinal meningitis (Voltolini described this form of inflammation as a primary inflammation, but there is not much doubt that it is an affection secondary to a more or less localized meningitis), with the acute infectious diseases (measles, scarlet fever, diphtheria, etc.) or epidemic parotitis, etc. Most of the symptoms abate or disappear in a few days to a few weeks, but the staggering gait and deafness are more persistent—the latter rarely improving to any great extent. Functionally, the upper-tone limit is greatly lowered; B.-C. markedly reduced throughout or destroyed for part or all of the musical scale; A.-C.>B.-C.; the power of equilibrium much impaired. The less acute forms of exudative inflammation of the labyrinth give rise to vertigo (unless confined to the cochlea), to sudden loss of hearing power, intense tinnitus, lowering of the upper-tone limit, with B.-C. reduced or absent, A.-C.>B.-C., and to disturbances of equilibrium.

In **affection of the nerve-trunk** the most prominent symptom is impairment of hearing. There are also present tinnitus, vertigo, staggering gait, and excessive functional exhaustibility (Gradenigo). Usually unilateral, it may be bilateral, as in tabes dorsalis. Hardness of hearing is usually most pronounced for the tuning-forks of middle register (Gradenigo), perception for high and low notes being fairly well preserved. B.-C. is very much impaired.

Word-deafness (sensory aphasia) furnishes the most reliable sign of involvement of *the cortical area*, usually of the left first temporal convolution. The function of both ears is usually impaired; tinnitus is more commonly absent; B.-C. is reduced in duration (see page 779).

Concussion of the head may provoke symptoms indicating an involvement of the sound-perceiving apparatus even up to complete deafness, and this latter may be induced without any recognizable changes being necessarily found in the labyrinth on post-mortem examination (Gruber). The symptoms usually present are diminution of hearing, tinnitus, vertigo, headache, unconsciousness, pain occasionally, occasionally acoustic hyperesthesia or alteration in pitch of certain tones, etc., one or all. These symptoms have been explained as due to shock to the acoustic nerve (Buck), basilar inflammation resulting from a blow (Buck), or hemorrhage at the point of origin of the acoustic nerve (Moos).

Fractures of the petrous bone, involving the labyrinth, are accompanied by hemorrhage from the meatus, or if the tympanic membrane is not ruptured, the blood may pass through the tympanum and the Eustachian tube into the throat (Buck); serous-looking discharge in considerable quantity; very pronounced subjective noises; disturbances of equilibrium and vertiginous symptoms; facial paralysis in 55 per cent. of the cases (Schmidt). In both concussion and fracture the functional tests of involvement of the sound-perceiving apparatus are present.

Neurotic disturbances of the sound-perceiving apparatus, which may be unassociated with pathological anatomical alterations, are by no means uncommon, and are described below.

Acoustic neurasthenia has as symptoms impairment of hearing, varying from mere slowness (acoustic torpor or lassitude) to considerable deafness, especially marked under any prolonged strain or confusion of sound, mental anxiety, or extreme physical fatigue (Poli), and improving rapidly after rest. Tinnitus may or may not be present, and is increased by fatigue; paresthesiæ are common, with great fluctuation of the ability to hear; the upper-tone limit is not apt to be impaired; but the duration of B.-C. is lowered throughout the musical scale, and there is great functional exhaustibility of the acoustic nerve. Either one or both ears may be involved, though usually both. The patients are generally neurasthenic, and any circumstance which aggravates this condition is the cause of marked decrease in the hearing (Gellé). This condition is frequently associated with that following.

Acoustic hysteria is usually associated with great deafness, which appears suddenly and is not subject to the fluctuations noticeable in neurasthenia; it is the same throughout the continuance of the attack. Vertigo is never present (Rohrer), and tinnitus is not frequent; one or both ears may be affected or the attack may pass from one ear to the other; paresthesiæ or anesthesia of the external auditory canal and the tympanic membrane may be present (Würdemann); functional tests are apt to be contradictory, the most constant being lowering of the upper-tone limit.

Hyperacusis is an overexcitable condition of the acoustic nerve, sometimes even painful, occurring generally periodically in connection with great nervous or mental excitement, with neuralgiæ, or after partaking of stimulants (Politzer). It also occurs in the incipiency of inflammatory affections of the ear.

Paracusis consists in the false perception of the pitch of a sound. *Paracusis loci* is the inability to tell the direction from which the sound comes, and depends upon the difference in the acuteness of perception of the two ears. As our judgment of the direction of sound depends upon binaural hearing, in unilateral deafness the apparent source of the sound will be projected in the direction of the normal-hearing ear (Politzer).

Diplacusis is a form of paracusis in which a single tone is heard double; either each ear perceives the tone differently and it seems doubled (D. binauricularis—Knapp), or a double perception of a single tone is got by one ear (D. monauricularis): the two tones differ from each other in time (D. echoica) or in interval (D. harmonica or disharmonica—H. Daae).

"**Nervous tinnitus**" (Politzer) may exist as a pure neurosis without difficulty of hearing. It is observed as an irritable condition of the nerve in convalescence from severe febrile affections; in connection with sexual excesses, intemperance, overfatigue of the auditory nerve, and extreme mental disturbance. It may continue indefinitely, the hearing remaining unimpaired.

Hallucinations of hearing may occur rarely in ear-diseases without a changed condition in the brain (Politzer).

Color-hearing is a term employed to define that phenomenon by which certain tones always excite in some people the sensation of color.

Deaf-mutism.—One of the most important results of labyrinthitis is the production of deaf-mutism. In the United States there were about 38.2 deaf-mutes to every 100,000 inhabitants (v. Tröltsch), but this proportion is apparently diminishing. They belong, to a great extent, by birth to those classes of society which are least favorably situated economically as well as socially (H. Mygind). In the majority, the deaf-mutism develops before the end of the third year (Robertson), but may develop as late as the eighth year (Lemcke). The pathological seat of the causative process is, almost without exception, in the labyrinth (H. Mygind). In connection with the labyrinth, the middle ear is surprisingly often found to be affected, only exceptionally as regards lack of formation, but almost regularly by violent inflammation, generally of a purulent nature (H. Mygind). Deaf-mutism occurs more frequently in the male sex (v. Tröltsch). More than half the cases are due to acquired deafness (H. Mygind), and epidemic diseases are probably most often the cause of the deafness (H. Mygind). Bezold is probably nearly right in his statement that about 43 per cent. are totally deaf, and it is the general opinion that among these the acquired are greater in number than the congenital (Hartmann). There is noticeably a very frequent occurrence of partial defects in the musical scale, in which sometimes the upper and sometimes the lower limits of tone are absent; sometimes single or multiple gaps or islands are found which show no perception at all (Bezold). Only about 8.4 per cent. have hearing power sufficient for intercourse with other people (Lemcke). Disturbances of equilibrium (static or dynamic) are present in 50 per cent. (A. Bruck), and those showing normal equilibrium are also much more apt to have normal speech (L. W. Stern). Heredity exerts a great influence, especially in those families in which there are many cases of hardness of hearing, but direct transmission is absent, as Mygind found that not a single child of deaf-mute parents was itself deaf and dumb. Consanguineous marriages are only causative when joined to hereditary and other influences (as constitutional disease)—(L. Blau). Deaf-mutism is especially apt to occur in those families in which many children have been born in rapid succession (H. Mygind). Gillespie has drawn attention to the frequency of goiter in deaf-mutism; and Lemcke, of affections of the naso-pharyngeal tract, especially adenoid vegetations. The bodily growth keeps pace with that of normal persons, but there is defective brain development (Lemcke); as a rule, however, they are endowed with organic, mental, and normal sensitiveness but little inferior to the normal (Ottolenghi). They do not exhibit a higher mortality than normal individuals living under the same circumstances (H. Mygind), but they are especially prone to lung-diseases. Nearly half of all deaf-mutes over 20 years of age are obliged to fall back on the help of others for their maintenance (H. Mygind). Marriages contracted by deaf-mutes exhibit a very small degree of fertility (H. Mygind).

Diagnosis.—The diagnosis has been almost sufficiently indicated in the symptomatology, but there are a few points that it seems well to emphasize.

In any case of hardness of hearing the first thing to be determined is whether the lesion is located in the sound-conducting or in the sound-perceiving apparatus. The antagonistic reactions to the functional tests may be tabulated as follows:

Diseases of the Sound-conducting Apparatus.	*Diseases of the Sound-perceiving Apparatus.*
Upper-tone limit very little, if any, lowered.	Upper-tone limit noticeably lowered.
Lower-tone limit by A.-C. elevated.	Lower-tone limit by A.-C. not elevated.
Absolute duration of perception of B.-C. increased throughout the musical scale.	Absolute duration of perception of B.-C. diminished or abolished throughout all or in parts of the musical scale.
B.-C. > A.-C. both in intensity and duration in the lowest part of the musical scale, and ascending with the gravity of the disease (Rinné).	A.-C > B.-C. both in intensity and duration throughout the musical scale (+ Rinné).
Weber's test heard in the diseased or the harder hearing ear.	Weber's test heard in the normal- or better-hearing ear.
Deeper tones of speech not heard; higher tones well heard.	Deeper tones of speech well heard; higher tones not heard.

In order to bring these differing reactions more graphically before the eye, the author has arranged them below in the *schema* originally devised by himself, first giving the normal reaction in the healthy ear for comparison—the numerals representing the duration of perception in seconds, the Rinné showing whether the respective forks are heard louder by A.-C. or B.-C. at the initial point.

In marked disease of the sound-conducting apparatus the reaction will be approximately as below:

A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	Rinné.	B.-C.	B.-C.	B.-C.	B.-C.	B.-C.	Equal
22 12	25 13	15 $7\frac{1}{2}$	33 13	32 13	22 14	Schwabach $\left\{\begin{array}{l}\text{B.-C.}\\\text{A.-C.}\end{array}\right.$	0 14	8 14	8 11	13 17	15 16	13 14
C^{-I}	C	C^{I}	C^{II}	C^{III}	C^{IV}	Tuning-fork.	C^{-I}	C	C^{I}	C^{II}	C^{III}	C^{IV}
Galton $1\frac{5}{10}$			Weber =				Galton[1] 2			Weber in the affected ear.		

Average normal ear.

Average case of otitis media purulenta recurrens.

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[1] It will be noticed that the upper-tone limit is slightly impaired in the scheme; this is in keeping with the author's findings as described in the article "The Upper-tone Limit in the Normal and Diseased Ear."

In disease of the sound-perceiving apparatus the following reactions will serve as a type :

A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	A.-C.	Rinné.
12 4	17 6	18 7	21 6	15 4	10 2	Schwabach A.-C. B.-C.
C^{-I}	C	C^{I}	C^{II}	C^{III}	C^{IV}	Tuning-fork.
Galton 2.7			Weber in the better-hearing ear.			

Average case of otitis interna.

In cases in which there is an affection of both the sound-conducting and sound-perceiving apparatus, both upper- and lower-tone limits are contracted, the duration of B.-C. is impaired, B.-C. is better than A.-C. (—Rinné) for the lower forks, while A.-C. is better than B.-C. (+Rinné) for the higher forks, and both the higher and deeper tones of speech are imperfectly heard. The degree in which one or the other apparatus is responsible for the hardness of hearing is indicated by the closeness of the resemblance of the results of the functional tests to the reactions given by the one or the other type of disease.

In the matter of locating the lesion in any particular portion of the sound-perceiving apparatus much has yet to be learned, but the following deductions seem to be well established as the result of post-mortem examinations of cases clinically observed before death : word-deafness points to involvement of the cortical areas ; lower- and upper-tone limits fairly well preserved with deafness for forks of middle register and greatly impaired B.-C. indicate involvement of the nerve-stem (Gradenigo) ; disturbances of equilibrium may occur in the course of any pathological process causing irritation of the terminal filaments in the vestibule or ampullæ, of the nerve-fibers in the auditory nerve-stem (Kreidl), or of the central origin of the nerve (Hillairet) ; pathological processes involving the cochlea alone do not induce vertigo (Gradenigo) ; the cochlea is the only part specialized for the perception of sound, as the retina is for light, and its total destruction is followed by total deafness ; it is probable that the lower notes are perceived at the cupola, and the higher notes at the base.

In attempting to make a diagnosis these deductions should be borne in mind while studying the results of the functional testing, remembering always, however, that it is often impossible to determine whether the disease is in the labyrinth, nerve-trunk, or central course (Politzer).

In fracture of the petrous bone, the escape of cerebro-spinal fluid is not essential (Gruber), and no certain conclusions with respect to the anatomical situation, gravity, or the subsequent behavior of the fracture can be drawn from the external appearances in the ear and from the functional disturbances (Schmidt). In most cases both the internal and middle ear are affected together (Schmidt). Fracture may occur without loss of hearing (J. E. Sheppard) if the labyrinth is not involved in the fracture line.

The diplacuses are, in the author's experience, usually due to affections of the middle ear, as in a case recently observed of diplacusis echoica coming on during the acme of an attack of otitis media subacuta.

The neuroses are recognized by their symptoms and the peculiar constitutional condition of the patient.

Bearing in mind the above few remarks in connection with those on symptomatology, the diagnosis, according to our present knowledge, should not offer insuperable obstacles to the conscientious observer.

Prognosis.—The prognosis is always hopeful in those cases in which there has been no destruction of the anatomical elements, as in anemia, neurasthenia, etc.; always unfavorable in those cases in which such destruction has taken place. The condition remaining after a trial of treatment of moderate duration is apt to be the condition that will remain permanently, except in the case of hemorrhage, where repeated attacks will tend to further impairment of hearing.

Amelioration may and usually does take place in the other symptoms, such as vertigo; but the hearing improves only so far as the anatomical elements develop recuperative power, and when that power is exhausted, improvement ceases.

Treatment.—The treatment of anemia of the labyrinth is in most cases practically that of the treatment of general anemia, as in the anemia and oligemia following gestation and parturition. In the local anemia due to aneurysm or atheroma very little can be done; when due to pressure brought on by changes in the middle ear, operative interference to relieve that pressure, if possible, should be undertaken.

Hyperemia, if acute, should be met by local blood-letting, purgation, and rest at the same time that the diet is limited and stimulants interdicted. The causative agency should always be searched for and corrected as far as possible on general lines. Regulation of the diet and bowels, curtailment or denial of stimulants, and correct ordering of the care of the body and method of life are always indicated and produce the best results.

Hemorrhages into the labyrinth should be treated, until the acute symptoms subside and absorption begins, by complete bodily rest, local blood-letting, purgation, hot foot-baths, limitation of diet, and abstinence from the use of all stimulants, alcohol, tobacco, etc. Later, comparative rest and abstention from mental or physical work, with the regulation of the diet and bowels, will do more to favor absorption than the administration of drugs. Should this method of treatment be found impracticable, or conjointly with it, iodid of potassium in gradually increasing doses has given the best results in the author's hands. Pilocarpin has been strongly advocated by some authors, given either by the mouth or hypodermatically, beginning with one-eighth of a grain two or three times daily and working up until the physiological effect is obtained, when the patient is held to that dosage for a shorter or longer time.

In the hyperplastic form of labyrinthitis, regulation of diet and digestion, of the bowels, and denial of stimulants, counter-irritation over the mastoid, and attempts to provoke derivation and, most important, the attempted removal of the cause. Resolution may be encouraged by the administration of iodid of potassium or of pilocarpin, if these are not contra-indicated by the condition causing the lesion or by the state of health of the patient.

During the acute stage of the exudative form of labyrinthitis as much should be done as possible to decrease the intensity of the attack and to limit the extension of the process. This in most cases amounts to very little. Rest in bed is imperative, limitation of the diet, cardiac sedatives, diaphoretics, regulation of the bowels, and derivatives not contra-indicated by the general condition. After the acute symptoms have subsided, resolution is to be encouraged by the continuance of rest, light but nourishing diet, the regulation of the excretory organs, and the administration of those remedies known to have an effect on the pathological deposits and new formations, such as the iodid of potash, mercury, pilocarpin, etc.

The regeneration of the affected nerve-elements may be encouraged by the administration of the various nerve-stimulants and nerve-foods, such as strychnia, phosphorus, etc.

The principal treatment for concussion and fracture is rest and the meeting of symptoms as they arise.

The treatment of acoustic neurasthenia is, of course, that of the general neurasthenic condition. The general health should be improved by all the means at our command. The author has found that the feeling of well-being produced by the administration of gelsemium is a very important aid in inducing the patient to attempt and to adhere to those regulations necessary to the attainment of this much hoped-for improvement; it should be administered in the form of the fluid extract. Strychnia has produced only a temporary improvement in the author's hands. The general health must be improved if any permanent betterment is to be attained, and gelsemium has the power of stimulating the ambition of the neurasthenic to the extent of accomplishing the tasks necessarily set for this purpose.

Hysteria requires the administration of those remedies—pharmaceutical, psychical, and physical—usually recommended for use in the general condition.

The various other neuroses, reflex and otherwise, are to be treated from the standpoint of the cause.

It will be noticed that the subject of the treatment of affections of the sound-perceiving apparatus by means of electricity, phono-massage, and various other more or less imperfectly tried remedies has not been touched upon by the writer. The reason for this lies in the fact that the advantage to be derived from these remedies has been much doubted by very many competent otologists who have given them fair trial, and that certain disadvantages in their use have been discovered in some conditions. Further attention needs to be devoted to them as remedial agencies.

The treatment of deaf-mutism consists in the removal of any curable pathological conditions found to exist in the sound-conducting apparatus and the improvement of what hearing power still remains in the sound-perceiving apparatus. Chronic suppuration of the middle ear is especially prevalent among those mute from acquired deafness, and should receive competent attention to prevent fatal results. Urbantschitsch has recommended systematic acoustic instruction by the pronunciation of vowels, consonants, single words, and sentences; the instruction to be given for a short time two or three times daily. Politzer is of the opinion that this may be the means of effecting a modulation in speech, but that the hearing cannot be affected thereby, because it has generally been lost through processes which have run their course and have left behind irreparable anatomical changes.

OPERATIONS.

By J. ORNE GREEN, A. M., M. D.,

OF BOSTON, MASS.

OPERATIONS ON THE AURICLE.

Auricular appendages are composed either of fat or cartilage covered with skin (Fig. 520). Their removal for cosmetic effect by an elliptical incision is usually simple. If they are cartilaginous, the cartilage often extends inward quite deeply, but the removal of the whole is unnecessary; it is sufficient to cut off the cartilage just below the level of the surrounding surface and suture the skin.

Coloboma of the lobule may be congenital or acquired, the latter usually caused by heavy ear-rings, which have slowly cut their way out. The operation for both varieties is practically the same (Fig. 521). Cut a strip of skin from *a* to the lower edge of the lobule and turn it down; from the same point, *a*, freshen the edges as far as *b* by removing a thin strip; suture the lobule at *c* and *d* by transfixing sutures, then suture *a* to *b* by fine sutures, and the skin at any gaping spots also by fine sutures. The results

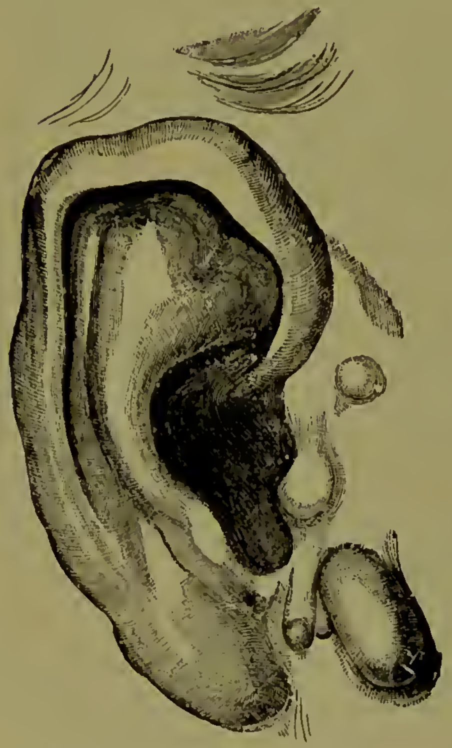

Fig. 520.—Polyotia of auricular appendages, consisting of the nipple-like outgrowths in front of the ear (v. Ammon).

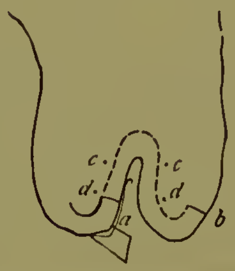

Fig. 521.—Operation for coloboma of lobule.

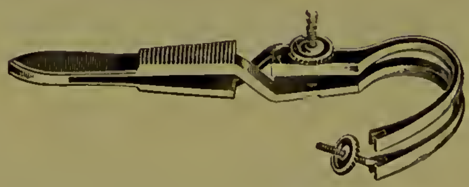

Fig. 522.—Snellen's clamp for bloodless operation on the lids or lobule.

in the acquired fissures are almost perfect; but in the congenital variety are not so good, as the edges of these fissures are apt to be somewhat atrophied. Hemorrhage during the operation can be wholly avoided by enclosing the lobule in a Snellen's clamp (Fig. 522).

Fissures of the auricle, either congenital or the result of traumatism, may be corrected in the same manner as those of the lobule.

Macrotia, or abnormally large auricle, has been improved by Schwartze in the following way: An elliptical piece of the cartilage was removed from the fossa of the helix, and then a triangular piece from the helix well into the concha; the edges were then united by deep sutures.

Projecting Auricle.—To tie down an auricle which is protruding from the head make two concave incisions 5 cm. long behind the ear, one on the mastoid 1 cm. backward, and one on the auricle 1 cm. forward, with the concavities facing each other, the cuts uniting above and below at acute angles. Dissect off this skin, loosen the remaining skin at the edges for 0.5 cm., unite the edge by sutures, press firmly into position by iodoform gauze, and bandage the auricle firmly against the skull.[1]

Grooving or excising a segment of the cartilage in the fossa of the helix is needful in some cases, as in the previous operation.

Defects of the auricle can rarely be benefited, because the defect is usually too great to be improved by plastic surgery. In exceptional cases, however, a fairly well-formed auricle is simply adherent to the skull and can be dissected off; a flap of skin can then be inserted behind and a considerable gain in appearance thus obtained.

Congenital fistula, a remnant of the fetal first branchial cleft, only requires surgical interference when the secretion is so abundant as to be a serious inconvenience, when there is retention and the formation of a large cyst, or when the fistula becomes infected and suppurates. In such cases the only effectual course is to dissect out the entire epithelial lining of the tract, which usually extends quite deeply, one-half inch or more. In two cases which I operated upon the removal of the deepest portion of the fistula exposed the capsular ligament of the temporo-maxillary articulation.

Wounds of the auricle usually heal wonderfully well, even if deep in the cartilage. Wounds at the orifice of the meatus, if granulating, are liable to cause stenosis or atresia, which must be guarded against by packing, cauterization, removal of granulations, or by grafting of skin.

Fibroma of the lobule, ear-ring tumor or keloid, requires complete removal by taking out a triangular piece of the lobule; any portion of the new growth left will cause a recurrence of the tumor. Pass a narrow-bladed knife through the lobule in healthy tissue above the middle of the tumor and incise through the base of the lobule in healthy tissue; do the same on the opposite side and bring the parts together by deep sutures. The operation is practically the same as that for coloboma, except in the care necessary to excise all of the growth; and if it is possible to get a narrow flap of healthy skin and insert it on the edge of the lobule, as described above for coloboma, the disfiguring notch in the contour of the lobule will be avoided.

Atheromatous, dermoid, and **serous cysts** require the removal of the entire cyst-wall by dissection.

Angioma.—The treatment must vary according to the size of the growth: if small it can be dissected off and the skin sutured over the wound, or it may be destroyed by the thermocautery or by electropuncture. Large growths involving the whole thickness of the auricle may require amputation of the portion of auricle involved. Occasionally the whole auricle is involved in a mass of large tortuous blood-vessels which communicate freely with enlarged and irregular arteries arising from the carotid. In these amputation by slow dissection, ligating the vessels as they are cut, is our only resource; and ligation of the common carotid artery must precede the amputation. After removal of the auricle the deeper tortuous veins can be dissected out. Then, as in every wound involving the orifice of the meatus, an attempt should be made to turn a flap of skin into the meatus to prevent atresia from granulation-tissue.

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[1] Gruber: *Monatschrift für Ohrenheilkunde,* Feb., 1896.

Epithelial Carcinoma.—Our only resource is early extirpation by excision; if small, excise the growth with the whole thickness of the cartilage; if large, amputation of the entire auricle is necessary, and, if the tissues within the orifice of the meatus are involved, the entire cartilaginous meatus should be removed with the auricle. Any infiltrated glands should be dissected out. If the orifice of the meatus is involved, a plastic operation should supply a surface of skin, at least on one side, to prevent atresia.

Some cases do well, and I have followed such for several years without there being any recurrence; in other cases there is a rapid return, either in the cicatrix or in the meatus, which is usually fatal in a few months from involvement of the deeper ear and brain or of the parotid region. A recurrent growth, small and isolated, justifies a second operation; but a rapid recurrence in the form of a diffuse infiltration, usually in front of the tragus, is, in my opinion, beyond surgical relief.

OPERATIONS ON THE MEATUS.

Congenital atresia is usually associated with malformation of the auricle, and in most cases also with malformation of the middle and inner ears from imperfect development. This internal malformation renders surgical interference inadvisable except in the rare, simplest forms where the closure is merely by a thin layer of skin and where an exploratory puncture shows there is no fibrous or osseous closure further in. The skin can then be excised by a circular incision as near the periphery as possible, or quartered by two cross-cuts and the triangular flaps excised with curved scissors. By either method great difficulty is experienced in maintaining the opening, which can only be done by keeping a tube, metallic or rubber, in the passage until the skin has united over the wound, or else by a plastic operation inserting skin from the concha or tragus. Secondary contraction may occur unless combated long after apparent healing.

Acquired atresia is the result of granulation-tissue within the meatus, which, uniting across the passage, has fused into a connected mass, undergone fibrous organization, and been covered with epidermis. A successful operation here depends very much on the same conditions spoken of under congenital atresia, except that there is no question of malformation of the middle and inner ears. In many of these cases the occluding membrane is thin, $\frac{1}{32}$ to $\frac{1}{16}$ of an inch in thickness; but occasionally the entire meatus is converted into a dense fibrous tissue. If the membrane is thin, the same operation described for congenital atresia holds good; but where a considerable portion of the meatus is occluded by fibrous tissue, I do not believe any operation will succeed in making a permanent opening.

Carcinoma of the meatus is usually of the epithelial variety and an extension of the same disease from the auricle. If it involves only the cartilaginous meatus it can be removed together with the auricle (see Carcinoma of the auricle); if it involves the osseous meatus, however, an operation is, in my opinion, unjustifiable, as it cannot be successful and is liable to set up increased activity in the morbid growth. Varieties of carcinoma of the meatus other than epithelial are extensions of the disease from neighboring parts, usually from the parotid gland.

Granulations, inflammatory growths of granulation-tissue, are usually an expression of some other trouble—deep-seated inflammation and often caries; but their removal is demanded to give exit to pus or to get at the deeper disease. If pedunculated they can be cut off with a No. 30 or 33 copper wire in a Wilde's snare, or removed by evulsion with forceps or curetted away. Cocain in 10 per cent. solution is useful both for local anesthesia and to diminish the bleeding. After the removal the underlying disease requires its appropriate treatment; and until this is cured the possibility of recurrence is not excluded.

Exostoses.—Their removal is demanded only when they close the meatus, thus producing serious impairment of hearing, or when there is suppuration of the deeper structures and the growth prevents the evacuation of pus.

If distinctly pedunculated, it may be possible to separate them by placing a small osteotome against the pedicle and fracturing this by a sharp blow from a mallet, then removing the growth with forceps. If not pedunculated, the growth can be best reached by deflecting the auricle and cartilaginous meatus forward. This is done by beginning at the extreme upper anterior edge of the auricle and carrying an incision $\frac{1}{2}$ cm. from the auricle behind, around, and down to the lower wall of the meatus through the skin; then dissecting off the auricle without the periosteum until the meatus is reached, when the periosteum is incised close to the meatus above and behind and separated together with the cartilaginous meatus from the bone until the exostosis is reached. This can then be thoroughly exposed by drawing the separated auricle and meatus forward with a long flat hook. The growth can now be removed by chisels and mallet or by burrs on a surgical engine. Strict asepsis is, of course, necessary. After removal the periosteum should be carefully replaced together with the cartilaginous meatus, the auricle stitched into position, a light packing of dry iodoform gauze placed in the meatus to retain the periosteum firmly against the bone, and an aseptic dressing applied over the whole ear and mastoid. The frequency of dressings must depend upon the condition of the ear: with suppuration, daily dressings are necessary.

Hyperostosis, a general hyperplasia of the bone, is particularly liable to occur with chronic suppurations of the tympanum; and if the hyperostosis closes the meatus an operation may be a vital indication to prevent retention of pus.

In such cases two methods are applicable. One is to drill through the growth in the meatus with a surgical engine and enlarge the opening by burrs. This has been done with success: but the opening thus obtained is a small one which, becoming covered with granulations, is kept open with difficulty; and, as the hyperplastic process in the bone will probably continue, a renewed closure is likely to occur even when the seat of operation has healed well.

The other method is to do a full tympano-mastoid exenteration (see page 796), removing all the hyperostosis on the posterior wall. This has the advantage of making a large meatus, of enabling one to treat the underlying tympanic disease, if there is one, as is usually the case, and is much more likely to put a stop to further hyperplasia of the bone.

Exostosis Cartilagineæ.—Still a third form of osseous growth is occasionally found in the meatus, apparently congenital and probably developed from a remnant of fetal cartilage. To the American Otological Society in July, 1893 and 1894, I reported four cases of osseous growth, three on the mastoid wall of the meatus and one apparently arising from the tympanum; they differed from ordinary exostoses in being covered with cartilage and in lying free or but slightly attached to the cavities of the surrounding bone. They were removed by exposing them by displacement of the auricle forward and then extracting them with forceps, without any cutting of the bone. A full description and discussion of them can be found in the *Transactions*, 1893 and 1894.

Foreign bodies can, in most cases, be removed by syringing, and this should be tried in all cases; instrumental interference is unjustifiable except when syringing fails, either from the body being firmly impacted or becoming impacted by swelling from moisture. In these exceptional cases the ingenuity of the surgeon is sometimes taxed to the utmost to adapt his instrument to the peculiarities of the foreign body and its position in the meatus. *In children and nervous adults a general anesthetic is often required*, especially if the meatus is irritated from previous injurious manipulations.

Angular toothed forceps are adapted to bits of wood, grass, or similar objects. The wire loop of a snare can sometimes be passed around a pebble, and it can thus be gradually rolled out. A small sharp hook is very useful for peas and beans; a blunt hook for beads.

These are perhaps the most common instruments; but in a difficult case the surgeon's armamentarium can scarcely be too large. Occasionally a foreign body is so firmly impacted in the deeper meatus or tympanum that it cannot be displaced by any instrument through the meatus, either through lack of space to exert sufficient force, or through the body's having been forced beyond the narrowest part of the meatus and then having swollen, or through its having been impacted within the tympanum. In such cases the auricle and cartilaginous meatus should be displaced, as already described under exostoses; free access is thus gained to both osseous meatus and tympanum, and instruments adapted to the body can now be used with success. By this method I have successfully removed impacted glass, a tooth, and several flattened bullets from the tympanum, and swollen vegetable substances from the deeper canal, which it was physically impossible to have got out through the cartilaginous meatus.

OPERATIONS ON THE TYMPANUM.

Paracentesis.—Good illumination by means of a reflector and speculum is necessary. Asepsis in regard to meatus, auricle, hands, and instruments should be practised. The pain of the operation is very variable; if the drum membrane is bulging extremely from the pressure of secretion, its sensitiveness is often so reduced that but little pain is felt; if, on the contrary, it is very much thickened by infiltration, the pain is often severe. The natural sensitiveness varies also in different parts, being least in the lower half of the membrane and greatest in the posterior superior quadrant just behind the short process. The operation is so rapidly performed that narcosis is often unnecessary; but with children, with the timid, or where the drum membrane is much infiltrated, primary etherization is desirable.

The object to be attained is a cut through the drum membrane, in length from one-quarter to one-half of its diameter, and made in such a direction that both the radial and circular fibers of the membrana propria shall be incised, thereby insuring a slightly gaping wound from the contraction of both sets of fibers, facilitating drainage. The chief difficulties of the operation are (1) the judging of the distance, as only monocular vision can be used, and (2) getting the incision long enough, allowance not being made for the inclination of the membrane. The first can be overcome by keeping the point of the knife in slight motion as it is passed down the meatus, when, as the point touches the membrane, its motion is arrested and the puncture is immediately made by a slight thrust. The second is obviated by continuing to pass the knife slightly inward as the cut is made downward. Before withdrawing the knife the edges of the wound should be pressed apart to prevent their adhering with the slight bleeding which ensues.

Although various instruments with and without guards have been proposed, nothing in my opinion is so simple and good as the original paracentesis-needle of Schwartze, a small lance-shaped knife, the shank of which is 5 cm. long, bent at an angle of 50 degrees and inserted in a handle 10 cm. long. For enlarging an existing perforation or an insufficient puncture the blunt-pointed, slightly curved dilatation-knife of Schwartze cannot be improved.

The point of election for the operation will depend upon the object sought to be accomplished. The most common object is evacuation of secretion, and for this, if the drum membrane is greatly bulging, the cut should be made through the most prominent projection; if, however, there is no very conspicuous bulging it should be through the posterior lower quadrant, beginning a little above the umbo, midway between that and the periphery, and continued slightly obliquely downward to the lower periphery; this secures the most thorough evacuation and drainage. In paracentesis of the upper posterior quadrant, which is never advisable except with a bulging at that point, the risk of injuring the ossicles, especially the articulation of the incus and stapes, requires that the operation be done with great caution against too deep a thrust into the tympanum. A paracentesis of the anterior half of the membrane is never advisable except where there is a distinct bladder-like protrusion of the membrane at that situation, which is extremely rare; an opening at this point evacuates very insufficiently the secretion collecting posterior to the opening. When the drum membrane is much infiltrated it may be advisable in exceptional cases to make a cross-cut, thus giving a triangular flap, which, being pressed back, will keep the opening patent for a longer time.

The tympanum having been thus opened, if the secretion is thin and under any degree of pressure, it will evacuate itself freely; and if the Eustachian tube be open, slight inflation by Valsalva's method will complete the evacuation, and the air will pass out without râles, with the characteristic perforation-whistle. If the secretion is thick and adhesive or if the Eustachian tube is closed, it may be necessary to use the catheter, through which injections of warm sodium-chlorid solution ($\frac{3}{4}$ of 1 per cent.), boric-acid solution (5 per cent.), or some other mild and warm antiseptic solution may be used. My own practice varies with the case. In otitis media acuta with a thin bloody serum I content myself with following the paracentesis by simple drainage by means of a wick of corrosive-sublimate cotton, without inflation of any kind; with a simple acute effusion without congestion and with marked retraction of the drum membrane due to closure of the Eustachian tube (hydrops. ex vacuo), I use moderate inflation—most commonly by the catheter, because the force of the inflation with this is so completely under the control of the surgeon—although with children or timid persons Politzer's inflation may be necessary. In chronic catarrhal cases where the secretion is thick, often jelly-like and adhesive, injections by the catheter are frequently necessary to soften and wash out the masses, and aspiration from the meatus by means of Siegle's speculum will sometimes assist the evacuation; but care should be used to avoid any extreme congestion from the suction. In acute suppurations I avoid inflations at first; and if the secretion is too abundant and thick to be absorbed by a short wick, use hot syringing, especially if there is much pain.

Although paracentesis is most frequently used for evacuation of serum, mucus, and pus from the tympanum (and in all of these conditions is indispensable, and in the case of the last often life-saving), it is also occasionally useful for enabling us to get into the tympanum for the purpose of (1) dividing synechiæ, (2) removing intratympanic polypi, (3) relieving anomalies in tension of the drum membrane.

To get at *synechiæ* a short incision should be made as near their attachment as possible and the adhesions divided by passing a curved or right-angled knife through the opening. For *intratympanic polypi* a large opening, often with an extended cross-cut, is necessary—its situation dependent on the seat of the polypus. *Anomalies in tension* may be either increased or diminished tension. For the former, incision of the posterior fold as proposed by Lucae requires that the fold should be pierced close to the periphery directly behind the short process and the cut continued downward through the whole fold; although injury of the *chorda tympani* may result, it is of absolutely no importance. For diminished tension numerous small incisions in the most relaxed portion of the membrane have been advised with the object of increasing the tension by the resulting cicatrices. Neither of these operations for tension have, however, received general approval, as they but imperfectly relieve a single one of several pathological conditions which produce the deafness.

Tenotomy of the tensor tympani muscle for the relief of deafness and subjective noises produced by sclerosis or adhesive processes in the tympanum is of slight, if any, value. In my own hands it proved so worthless that I gave it up years ago. It can only relieve the retracted condition of the drum membrane; while we now know that the important pathological changes are on the inner wall, especially about the base of the stapes, and that these cannot be influenced by the operation. Almost the same thing can be said of *tenotomy of the stapedius* muscle; in a few exceptional cases I have seen a certain degree of relief to subjective noises and vertigo by this operation, where the stapedius was greatly thickened by cicatricial tissue resulting from previous suppurations and where the condition could be diagnosticated by direct inspection through a large perforation of the drum membrane.

Tenotomy of the tensor is performed best in the posterior superior quadrant by incising the membrane parallel with the manubrium, just behind and a little below the short process; the tenotome is then inserted through the opening toward the tympanic roof and with its edge forward until the head of the malleus is felt; it is then rotated forward until it engages the tendon of the muscle, which can be severed with a slight sawing motion. As the tendon is cut through it is felt to yield, and the manubrium with the drum membrane will be felt and seen to move outward more freely than before. By far the best tenotome is Schwartze's.

Tenotomy of the stapedius can be done with any small straight knife or with a paracentesis-needle when the stapes lies low and is exposed through a large perforation.

Excision of Parts or the Whole of the Conducting Mechanism.—These operations should be carefully divided into—

(1) Excisions for the relief of deafness otherwise incurable.
(2) Excisions for existing tympanic suppurations.

Under the first head the operations are undertaken with the object of removing parts of the conducting apparatus which have become so immovable by disease that they prevent vibrations from reaching the auditory nerve. The diseases producing this immobility are (*a*) adhesive inflammations (thickenings, calcifications, adhesions), the result of previous tympanic suppurations and catarrhs; (*b*) the obscure pathological process known as sclerosis, the important characteristics of which are changes on the inner (labyrinthine) wall of the tympanum and about the niche and foot-plate of the stapes.

It is impossible here to give the full history of the various operations which have been proposed; they can be briefly summarized as follows: excision of the tympanic membrane and malleus; of the incus; of the long process of the incus; of the tympanic membrane, malleus, and incus; of the stapes; of the tympanic membrane, malleus, incus, and stapes.

The methods of operating will be considered later, as they are the same whether done for deafness or for suppurations, except that in the former, with a healthy drum membrane, the strictest asepticism is absolutely necessary.

In regard to the **operations for deafness**, I think it can be said that in neither the adhesive nor the sclerotic diseases have the results equalled the expectations of their originators or received general recognition by otologists. In adhesive inflammations occasionally fair and even good results are obtained (see page 738); but only in a small proportion of cases as yet, and the indications for or against the operation are not established. In sclerosis any degree of success is so rare and the failures so many that for my own part I have given up all varieties of the operation for this disease.

With our present pathological knowledge only two of the operations for deafness are worthy of consideration:

(1) Excision of the tympanic membrane, malleus, and incus, leaving the stapes in position.

(2) Excision of the tympanic membrane, malleus, incus, and stapes. Which to adopt must depend upon the condition of the individual case. If the rigidity exists in the malleus and incus and, after their removal, the stapes is found by the probe to be freely movable, it should be left in position; if, however, it is immovably fixed and not to be released by the separation of adhesions of the crura to the niche, the only hope of success is in removal of this bone also.

For **tympanic suppurations**, removal of parts of the conducting mechanism is merely fulfilling the well-recognized surgical laws of removing obstructions to the thorough evacuation of pus so as to get surgical cleanliness and remove diseased bone (microbic foci) which keeps up the infection. It is especially indicated where the suppuration is in the epitympanum or attic; for the head of the malleus, the incus and stapes, the tensor tympani and stapedius muscles, the ossicular ligaments and many folds of mucous membrane are crowded into or below this narrow space; and a suppuration of the mucous membrane, which covers all of these structures, with its resulting swelling, often so interferes with free drainage that recovery is absolutely impossible without an evisceration of the cavity. In addition to this, the retention of pus is very apt to produce caries of the ossicles or of the petrous bone, which keeps up the suppuration. For both pus-retention and ossicular caries the operation is indicated and successful in a large proportion of cases. In performing it the whole of the existing drum membrane, together with the malleus and incus, should be removed; for any of these being removed the others become useless and merely act as obstructions to cleanliness; while in caries of the ossicles, pathological statistics show that both ossicles are usually diseased, but the incus more extensively than the malleus.

The different steps of the *operation* are as follows: (1) Separation of the drumhead by incision around its periphery as near the tympanic ring as possible.

(2) Tenotomy of the tensor tympani muscle by passing a Schwartze's tenotome over the tendon and dividing it, as already described on page 788. After severing the tendon the knife should be passed downward along the inner edge of the manubrium in order to separate any adhesions which are tying that bone down.

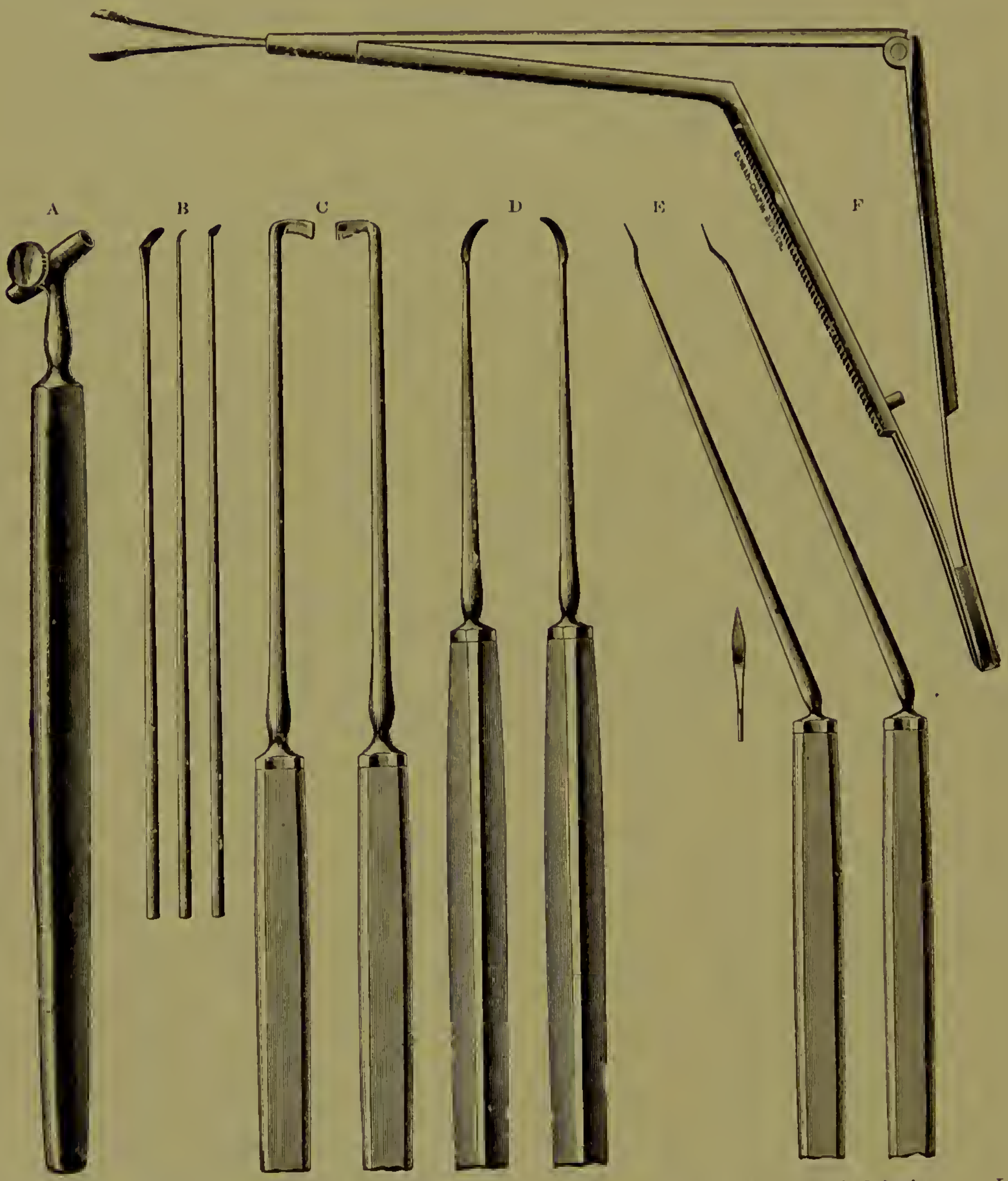

FIG. 523.—Instruments for intratympanic operations: A, adjustable handle; B, angled knives; C, Ludwig's incus-hooks; D, dilatation-knives; E, synechia-knives; F, Sexton's forceps.

(3) Disarticulation of the incudo-stapedial joint by incising it by short cuts with a small sharp-pointed knife set at nearly a right angle with its shank—the incisions being made in the plane of the joint, perpendicular to the axis of the stapes. If the stapes is situated low in the tympanum, the joint can

be seen; if high, the disarticulation must be done by feeling. A free movement of the long process of the incus proves the success of the disarticulation.

(4) Removal of the hammer by seizing it in strong forceps at or near the short process, carrying it slightly inward to bring the neck out from its insertion in the Rivinian notch, and then bringing the bone downward into the meatus and withdrawing it together with the drum membrane. Occasionally the incus comes away with the hammer, but usually it remains; if its long process is visible, it can be seized with forceps and withdrawn; if it is not seen, it must be brought down into view by an incus-hook, as described below (Fig. 523) in regard to carious ossicles, and then withdrawn.

(5) Separation of adhesions about the crura of the stapes, if any, can be accomplished by any small sharp-pointed knife or by a paracentesis-needle.

(6) Removal of the stapes, if that be desirable, is accomplished by inserting a small, blunt steel hook between the crura and drawing the bone out gently. Unless the foot-plate is ankylosed this can be done readily; but with ankylosis the crura fracture and removal of the foot-plate is then impossible.

The whole operation can be done under cocain with scarcely any pain if the patient is steady; but each successive portion of tissue requires to be cocainized by a pledget of cotton on an applicator. In an intact drum membrane the first puncture must necessarily cause pain, but from that puncture the saturated cotton-point inserted in the opening will thoroughly anesthetize about one-eighth of an inch of tissue; the cut can then be continued that distance and then another application of cocain made. Solutions of 5 per cent. are sufficiently strong. Absolute immobility of the head is required, and in a nervous patient general anesthesia is necessary.

In the operation for suppuration certain modifications may be necessary. In these suppurative cases there is often much granulation-tissue which bleeds freely, masses of inspissated pus and cholesteatomatous material, and the ossicles are often reduced to mere fragments, with calcifications fixing them so that considerable force is required for their removal. The most common spot for caries in the ossicles is the long process of the incus, which in 60 cases of my own had produced a natural disarticulation in 75 per cent., thus doing away with the operative disarticulation. With mere fragments of ossicles adherent by calcification, the Ludwig's incus-hooks are often necessary; and in removal of the incus, which is often reduced to a portion of the body only, these instruments I consider indispensable and prefer them to anything I have yet seen (Fig. 523). The malleus and tympanic membrane having been removed, the incus-hook should be passed into the anterior superior portion of the epitympanum, with its concave surface backward; it should then be swept backward so as to engage the body of the incus and bring it down into the meatus, whence it can be withdrawn by forceps. With a broad and deep attic several sweeps of the hook may be necessary in different portions of the cavity before the incus is dislodged, and in sweeping along the medial (labyrinthine) wall the position of the Fallopian canal should be borne in mind and but slight force used at this point; any twitching of the facial nerve is a signal of danger. Occasionally the incus is not brought into view by the backward sweep, but can be found by reversing the process and sweeping from behind forward. After removing the incus, the cavity should be thoroughly cleansed of cholesteatomatous masses, inspissated pus, and granulations by the Ludwig hooks, by snare and forceps. Bleeding can be greatly reduced by the use of cocain, and before beginning the operation I always inject the cavity with a 5 per cent. solution. In the operation for suppuration I have generally found etherization necessary, as the tissues are inflamed. The after-treatment consists of cleansing with the tympanic syringe and the use of antiseptics applied directly to the tympanum: a saturated solution of boric acid in absolute alcohol for granulations, simple boric-acid powder for a slight serous discharge, and a solution of carbolic acid in glycerin (1 : 25) for simple suppuration.

Polypi and granulations should be carefully distinguished from sarcomata or epitheliomata. Their removal is required because they keep up the inflammation of the parts to which they are attached, and because, if large, they cause retention of pus. Whatever their attachment, whether on meatus, tympanic membrane, ossicles, or tympanum, they must be got rid of before the inflammation can subside. They are almost without exception inflammatory granulation-tissue, soft or firm according to the amount of fibrous tissue which they contain; occasionally they contain cysts and exceptionally assume a teleangiectatic character from excessive development of blood-vessels. They usually are pedunculated, but occasionally are broad-based; and they vary in size from a pin's head to one inch or more long. They are the result of inflammation of the underlying tissue, often of a simple suppuration, often of a caries of the bone.

The choice of methods for removing them must depend upon their size, shape, character, and attachment. Small soft granulations can be destroyed by caustics, preferably argentic nitrate fused on a probe, or shrivelled by alcohol; but in most cases immediate removal is the quickest, surest, and least painful method. This can be accomplished with snares, forceps, or curettes.

Small pedunculated granulations can be seized and removed by evulsion with appropriate forceps if their situation admits of it; small broad-based ones, if soft, can be crushed by the same means; if firm and their attachment admits of it, they can be removed with a small curette. In either variety where evulsion is undesirable, as in attachment to the ossicles or drum membrane, a delicate snare will cut them off. Pedunculated granulations in the *epitympanum* or *aditus* can often be swept down and removed with the Ludwig incus-hook.

Large polypi attached to the walls of the meatus can also be removed with forceps by evulsion, but only exceptionally can their attachment be made out with such certainty as to justify this method; in almost all of these cases the snare is the only appropriate instrument.

The snare can be used either as an evulsor or as an écraseur, according to whether the wire is drawn against a cross-bar at the end of the instrument or completely into the tube in the absence of a cross-bar. The canula of the snare should be small and delicate for small granulations attached to delicate parts; much larger and heavier for large, especially for fibrous polypi. The size and quality of the wire should be adapted to the work also; for small growths on the tympanic membrane or ossicles I prefer a soft, malleable copper wire, even as small as No. 36; for large growths copper wire, No. 28 or 30; occasionally for large fibrous growths steel piano-wire, No. 2, is necessary. The malleable copper wire seems to adapt itself to the base of the growth better than a stiffer material, and I prefer it in almost all cases. The loop of wire, being made a little larger than the growth, is passed around it, bearing in mind the anatomical peculiarities at its attachment; the loop is then tightened or drawn into the tube and the tumor removed. Evulsion is to be preferred as more thorough where it is not liable to tear away important parts; where it is liable to do this the écraseur action is to be used. With large polypi it is often difficult to pass the loop completely down to the base. As much as possible is removed at the first insertion and the remainder by subsequent insertions. Except with very nervous persons general anesthesia is unnecessary, thorough cocainizing with a 10 per cent. solution being sufficient.

The subsequent treatment consists in destroying all remnants of the growth and getting the seat of it healed. If caries exists, the only course is to get rid of the process, for without this the growth is certain to recur, and the object of removing the polypus is to enable us to get at the caries. Without caries the remnants should be disposed of by cauterization or by shrivelling; for the former I confine myself almost entirely to argentic nitrate fused on a probe, applied superficially in case of a small remnant of a soft growth, or bored directly into the growth if the remnant is large and firm. For shrivelling, alcohol (95 per cent.) and glycerite of carbolic acid (1 :25) are very useful, applied either by instillation, by injection through a tympanic syringe, or by painting.

Mastoid operations are required for two pathological conditions : (1) pus in the pneumatic cavities of the mastoid, the retained products of suppuration of the mucous membrane lining the cells (empyema); (2) different varieties of ostitis, including suppuration of the diploë, inflammation of the cortical substance, caries, and necrosis. They are of two kinds : (*a*) opening of the mastoid antrum (Schwartze's operation); (*b*) cleaning out the whole interior of both mastoid and tympanum, a tympano-mastoid exenteration (Schwartze-Stacke or Schwartze-Žaufal operation).

The **antrum operation** consists in opening the antrum through the external mastoid cortex, and in so doing exposing the whole interior of the mastoid so as to remove all diseased tissue, whether osseous or soft. The antrum is the objective point to be reached, for it is the only constant cavity within the mastoid; the rest of the bone may be, instead of pneumatic, as usually described, diploëic or sclerosed. There is no method of determining beforehand the condition of the interior of the bone; a large prominent mastoid is more likely to be pneumatic than a small, depressed, ill-developed one; the bone in a dolichocephalic skull is more likely to be well developed and pneumatic than in a brachycephalic skull. It is equally impossible to foretell whether we shall find empyema, ostitis, or osteomyelitis; the opening of the bone finally settles the question. Osteosclerosis can be excluded in acute mastoiditis resulting from acute tympanic suppurations, unless the mastoid has been inflamed from some previous disease; it is unlikely in a mastoiditis which has shown symptoms of extension outward as subperiosteal abscess or extension downward into the neck; it can be strongly suspected in chronic, long-continued tympanic suppurations.

Certain irregularities of formation may be found in any mastoid, apparently regardless of its perfect or imperfect development.

(1) The roof of the antrum, which forms the floor of the middle fossa of the skull, may vary as much as 2 cm. up or down; the linea temporalis marks the line of this roof fairly well externally, and measurements on large numbers of skulls show that the floor of the middle fossa is never 1 cm. below the linea temporalis. A safe rule, then, to avoid opening the middle fossa is to keep 1 cm. below the linea temporalis, but as this linea is sometimes imperfectly developed, another rule is to make the upper edge of our opening 3 mm. below an imaginary line drawn horizontally backward from the upper edge of the meatus, which is well marked by the *spina supra-meatum.*

(2) The outward curving of the sigmoid groove which carries the lateral sinus varies very much; it may project even to the external cortex, and such a possibility must always be borne in mind, and possible wounding of the lateral sinus guarded against by the use of chisel and mallet worked slowly and carefully, and by the omission of all boring instruments, like trephine or drill.

(3) The extent of cancellated structure varies; it sometimes extends far backward and far inward; and as in osteomyelitis especially, the removal of nearly all cancellated structure is desirable, the possibility of this peculiarity should not be forgotten.

The floor of the antrum, roughly stated, is on a level with the upper wall of the meatus, and the cavity itself is from $\frac{1}{4}$ to $\frac{1}{2}$ inch back of the superior posterior edge of the tympanic ring.

Method of Opening the Antrum.—Expose the mastoid by an incision through the periosteum 1 cm. behind the attachment of the auricle, beginning 1 cm. above the linea temporalis and extending the cut down nearly to the tip of the process. Separate the periosteum forward so as to expose the *suprameatal spine*, and backward so as to expose the surface of the mastoid. From the spine draw an imaginary horizontal line backward (Fig. 524), and begin the upper edge of the opening 3 mm. below this line and about 1 cm. back from the posterior edge of the meatus, removing the cortex by thin chips with a gouge and mallet. The seat of election is usually marked by a flat and slightly depressed surface. The cortex of the bone varies in thickness from a thin shell to 1 cm.; remove it by thin chips over a surface 7 to 10 mm. in diameter, taking care to work parallel with the meatus, or, if anything, a little more forward and upward. As soon as the cortex is cut through,

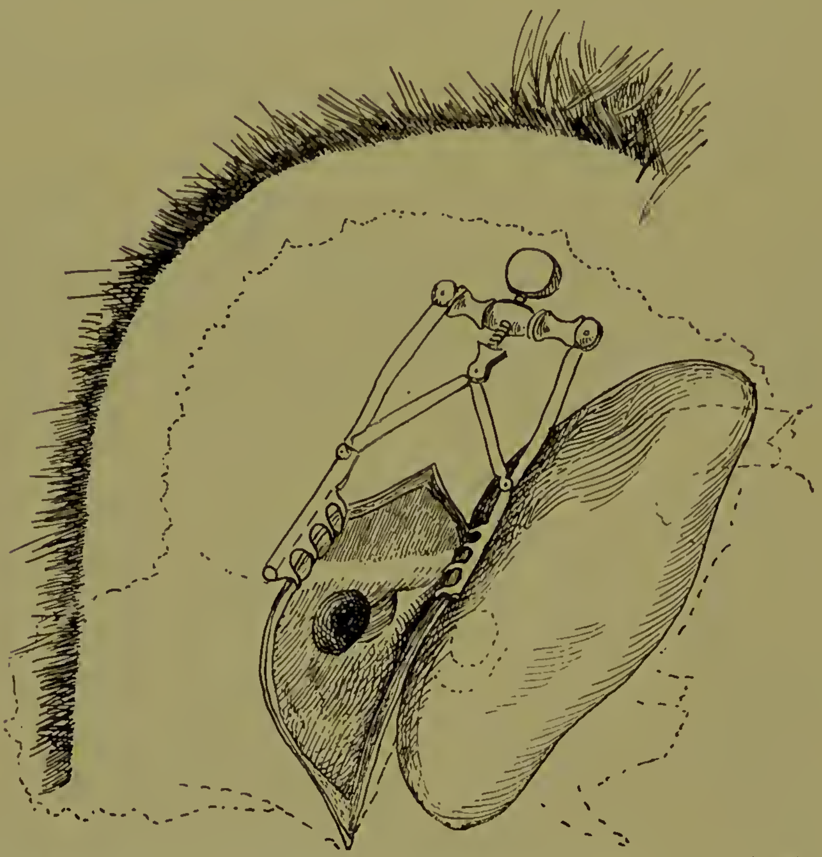

FIG. 524.—Operation for opening the antrum: external wound stretched by Allport's retractor, and bone opened behind suprameatal spine.

examine with a probe; there may be *large pneumatic cavities*, in which case feel for landmarks, upward for the roof of the mastoid to define the floor of the middle fossa, backward and inward to define the posterior fossa. Now break down all the partition-walls between the cells with a curette till the antrum is reached at a depth of not over 15 mm. ($\frac{10}{16}$ inch) from the outer anterior edge of the surface opening; clear out the involved interior of the mastoid with curettes, removing the walls of the cells, granulations, pus, and detritus, douche gently with corrosive sublimate (1 :5000), pack with iodoform gauze, and bandage.

In other cases on opening the cortex the interior is found to be *partly or wholly diploëtic;* more careful work is then necessary, and the diploë should be removed straight inward, parallel with the meatus, to the depth of 6 to 9 mm. ($\frac{1}{4}$ to $\frac{3}{8}$ inch), and then it is necessary to work slightly forward, inward, and upward to reach the antrum; but never go beyond 15 mm. ($\frac{10}{16}$ inch) from the external surface at the seat of election for fear of wounding the facial nerve or posterior semicircular canal. Having opened the antrum, the whole diploë of the mastoid should be removed with curettes, then cleanse, pack, and dress.

In still other cases no pneumatic or diploëtic structure is found; the deeper the opening is carried the harder the bone becomes—*osteosclerosis.* These are by far the most difficult operations; one gets no guide from the probe as in the other varieties of bone, and the greatest care is necessary to keep the proper direction of the opening. The bone should be removed in small chips, the opening carried straight in, parallel to the meatus, to the depth of 5 to 8 mm. ($\frac{1}{5}$ to $\frac{3}{8}$ inch), and then continued upward and slightly forward not deeper than 15 mm. ($\frac{10}{16}$ inch) from the external surface. Often after going through sclerosed bone for 7 to 14 mm. ($\frac{1}{4}$ to $\frac{1}{2}$ inch) diploë is met; this should be removed by curettes as thoroughly as possible; then cleanse and pack.

It is the exception to find the pathological condition as clearly defined as is here given; *caries* is very apt to complicate; and if during the operation carious bone is found, it should be thoroughly removed, care being taken to avoid wounding the dura mater, the facial nerve, and the labyrinth. Not infrequently the roof of the mastoid next the cerebrum is carious, also the inner posterior wall next the lateral sinus and cerebellum; these carious spots should be removed by a curette, the dura being pushed back from the bone. Narrow gauze strips can be carried into any crevice to stay the bleeding, and cleanse for thorough inspection. At any stage of any operation the removal of a small chip of bone may expose a gray shining membrane, which is a signal of danger; it may be cholesteatoma, pyogenic membrane, or dura, and must be examined carefully before proceeding. Extensive caries may require enlargement of the whole original opening.

The only cases which are exceptions to the above general rules of operating are those in which there has been *extension* of the internal suppuration *through a carious fistula of the cortex*—outward through the external cortex, forward through the anterior cortex, or downward into the neck through the mastoid floor. With *extension outward*, incise the periosteum as in the regular operation, expose the fistula and follow this in, clearing away all softened bone, and within the mastoid be guided by the existing conditions as described above. With *extension forward*, after the first incision expose the posterior wall of the osseous meatus by pushing the periosteum forward, and the fistula can be seen and followed. With *extension downward*, fistulæ are to be looked for in the base of the mastoid; this can be done by deflecting the periosteum from the posterior aspect of the mastoid tip and then passing a bent probe or director beneath the periosteum along the digastric fossa which constitutes the base of the mastoid. Having thus found the fistula, remove the outer surface of the tip, exposing the interior of the bone together with the fistula, and cleanse as in the other varieties.

These fistulæ are always to be suspected and carefully looked for when the external tissues are edematous and swollen; they are almost certain to exist whenever any pus is found between the periosteum and the bone; with extension outward the edema begins on the external surface; with extension forward, on the posterior wall of the meatus; with extension downward, beneath the mastoid in the neck, early assuming the characteristics of a cellulitis, which may form an abscess anywhere in the neck beneath the deep fascia and burrow extensively, even into the pleura. Next to the extensions to the brain these inflammations in the neck are the most serious complications of mastoiditis, sometimes requiring deep dissections of the neck, even to the vertebræ, in order to evacuate the pus.

With extensions toward the brain upward, inward, and backward, the tympano-mastoid exenteration is usually necessary.

The **tympano-mastoid exenteration** is well described by the name; it is an evisceration of the interior of the bone by making the mastoid, antrum, tympanum, epitympanum, and meatus one large cavity with perfectly smooth and healthy walls, by removing the external cortex of the mastoid, its entire cancellated structure, the posterior osseous meatus-wall, the tympanic membrane, the malleus and incus, and the outer wall of the epitympanum. It is indicated for simple caries of the bone which cannot be reached by the ordinary antrum operation—*i. e.*, caries of the tympanum, epitympanum, aditus and extensive caries of the mastoid, and also for cholesteatoma of the mastoid and tympanum. The variations in formation of the bone, the low-lying roof, the outward curvature of the lateral sinus, the extensive cancellated structure, are of as much importance to the surgeon in this as in the antrum operation. The same may be said of the measurements given in speaking of the antrum operation. In addition, in this operation the danger of wounding the facial nerve is much increased; and the course of the Fallopian canal and its relations to the floor of the aditus and to the posterior osseous meatus should be continually in mind, as well as the relations of the external semicircular canal.

There are two methods of getting at the antrum and aditus: one advocated by Schwartze, Zaufal, and their followers, who open from behind forward; the other advocated by Stacke, who opens from in front backward. The former extirpate the posterior superior membranous lining of the osseous meatus; the latter saves it to make a flap for covering the exposed bone.

The former operation is divided into seven steps:

(1) Exposure of the operative field;

(2) Extirpation of the posterior and superior lining of the osseous meatus;

(3) Exposure of the antrum by chiselling away the mastoid and posterior osseous meatus;

(4) Removal of the pars epitympanica;

(5) Exenteration of the tympanum and mastoid;

(6) Stitching and bandaging;

(7) After-treatment.

For the first step incise over the middle of the mastoid from 2 cm. above the linea temporalis to 2 cm. below the tip, and from the upper end of this cut make a horizontal incision forward for 3 to 4 cm. and backward also for 3 to 4 cm. From these cuts expose the entire mastoid by making a skin-periosteal flap forward to the meatus and the same backward. Secondly, separate the cartilaginous from the osseous meatus on its posterior and superior circumference, then incise the skin of the upper anterior wall of the osseous meatus from the tympanic ring outward; parallel with and opposite this make a similar incision along the posterior lower wall of the meatus; separate from the bone all of the skin included between these incisions on the upper wall from without inward and remove it with scissors, thus thoroughly exposing the upper and posterior walls of the meatus. Thirdly, enter the antrum as already described in the antrum operation, and then remove the wedge between this opening and the tympanum by chisels, or else chisel away the bone at once from the antrum surface (place of election for the antrum opening) forward into the osseous meatus, without first entering the antrum, going deeper and deeper until mastoid, antrum, aditus, tympanum, and meatus are united by a deep groove in the bone (Fig. 525). Check all bleeding, and the tympanic membrane or its remnants are now visible. Fourthly, separate any portions of the drum membrane which exist at the tympanic ring and remove them together with the malleus by forceps; disarticulate the incus from the stapes and remove it by forceps (see Operation for Carious Ossicles, page 791); it is usually buried in swollen mucous membrane and granulations. Now push the mucous membrane of the epitympanum inward and remove the whole floor of that cavity by gouge and mallet and curette till the roof of the epitympanum passes without any ridge into the upper wall of the meatus (Fig. 526). Fifthly, clean out all the cavities, removing all cancellated structure, all prominences and ridges, making every part smooth, beginning with the mastoid, then respectively antrum, epitympanum, roof of tympanum and its walls. Examine every portion of the remaining walls for caries with a

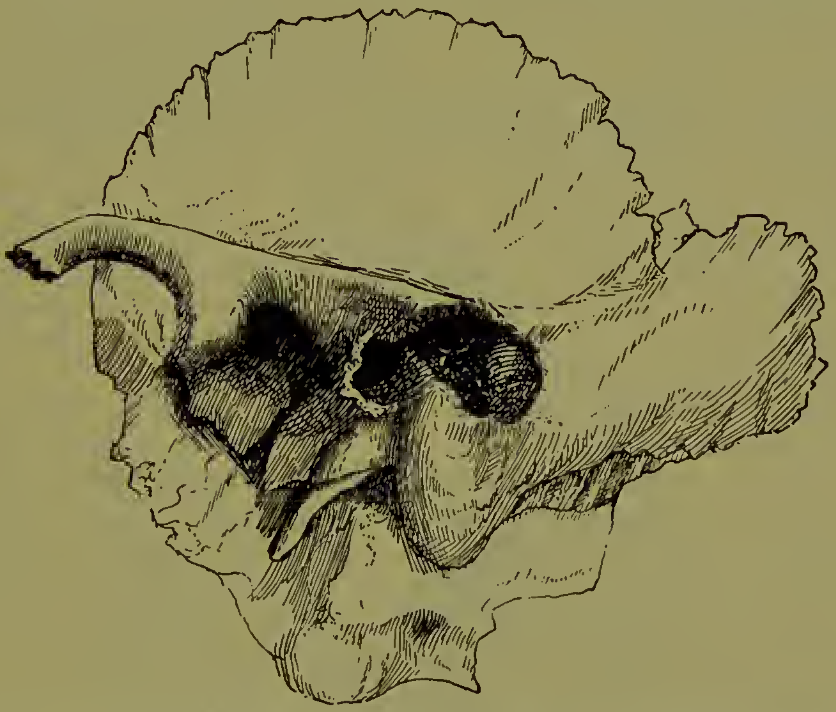

FIG. 525.—Tympano mastoid exenteration (soft parts not shown). The wall of the sigmoid sulcus is seen in the back of the mastoid opening, and the ridge of the bone protecting the facial is preserved between this and the meatus. If the mastoid is diseased, its whole external cortex should be removed to the very tip.

right-angled probe, especially the posterior wall of the antrum and its lower inner corner next the lateral sinus; and, if anything suspicious is found, remove it, even if it exposes the dura. Wipe dry with pledgets of gauze, taking care to remove all bits of bone. Finally, split the cartilaginous meatus from near the concha throughout its length along its posterior wall, thus making two triangular flaps (Fig. 526). Sixthly, stitch the horizontal wounds and 2 to 3 cm. of the upper part of the perpendicular wound, laying the skin-periosteal flap carefully against the bone; stitch the corners of the meatus-flaps above and below into the skin so as to stretch them up and down, and then pack the tympanum and antrum with iodoform gauze from the meatus, and similarly fill the mastoid from the wound; add an aseptic dressing and bandage. Seventhly, the after-treatment requires the most careful personal attention of the surgeon. The healing must take place, not by the cavities filling with granulations, but by granulation of the entire surface merely, which must then become covered by a firm, dry epidermis. The two chief points are to keep the wound aseptic and to keep down redundant granulation-tissue, which can only be done by keeping the whole cavity packed firmly with iodoform or sterile gauze, every little crevice receiving attention. If granulations become prominent, they must be removed by the snare, by argentic nitrate, or by the galvano-cautery.

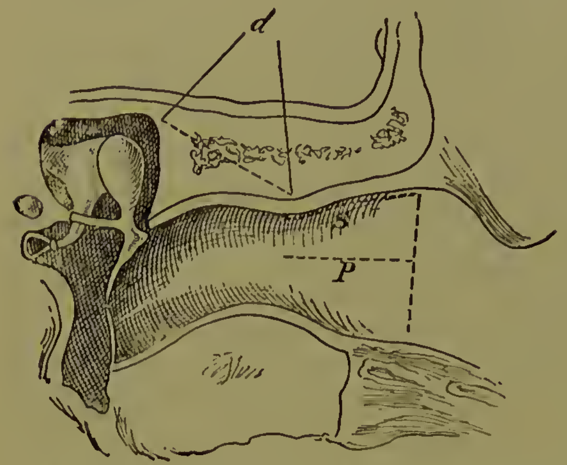

Fig. 526.—Section of tympanum and canal, showing by dotted line at (*d*) the wedge of bone removed to open the attic.

The details of Stacke's operation are as follows:[1] Make a curved incision at the insertion of the auricle or close to it from the temporal region to 1 cm. below the tip of the mastoid through the skin and subcutaneous tissue only. Dissect off the soft parts above the linea temporalis outside of the temporal fascia and draw them downward. From the *linea temporalis* downward extend the first cut through the periosteum and along the *linea*, make a cross-cut forward through the periosteum, thus making a triangular flap of periosteum, which is then raised by a raspatory as far as the edge of the osseous meatus; then with a narrow elevator raise the membranous meatus from the bone deeply into the osseous meatus till the whole posterior and upper osseous meatus is visible by drawing the parts forward. The whole mastoid should then be exposed by pushing its periosteum backward, if necessary making a cross-cut. If a fistula or discolored cortex exists, follow this into the antrum; then remove the posterior wall of the meatus and epitympanum.

If no fistula exists, with a small curved scalpel cut the posterior and upper membranous meatus as near the tympanic ring as possible, and draw this, together with the loosened auricle, forward by a blunt hook. After checking bleeding, the membrana tympani is visible; and the whole membranous meatus is retained to cover the bone.

The next stage is the exenteration of the tympanum by removing the drum membrane or its remnants, together with the malleus. Then place a gouge, bent slightly backward (Fig. 527), some millimeters above the free edge of the epitympanum and separate the bone by short light blows with a mallet, measuring the depth of the epitympanum with a bent probe, and continue removing the bone till the roof of the epitympanum is smooth and continuous with the upper wall of the meatus. The incus is now seen and removed.

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[1] *Die operative Freilegung der Mittelohrräume*, Tübingen, 1897.

Next pass a probe along the tegmen tympani into the *aditus* and with a small gouge, bent backward, remove the posterior superior meatus-wall into the aditus until the probe freely enters the antrum and a good orientation of every part is obtained. Instead of the probe, Stacke uses a protector, as he calls it. The external cortex and lateral portion of the posterior meatus-wall is now removed in large pieces by the chisel, the position and size of the antrum being known, and the antrum changed from a fistulous cavity into a narrow trough, which passes smoothly into the upper and lower meatus-walls without corners or sinuses. Medialwards the so-called spur between the antrum and tympanum must be smoothed, the now visible facial prominence forming the lower limit, which it is impossible to touch without endangering the facial nerve. From the height of this prominence the spur must be sloped off till it entirely disappears laterally in the lower meatus-wall. Here a minute artery of the bone is often encountered; and bleeding from it can be best checked by rubbing its orifice with a blunt instrument. All pathological products can now be removed under inspection, working carefully in the tympanum to avoid the stapes. The hypotympanum, as it is called by Kretschmann, only remains, and, except with caries of the tympanic floor,

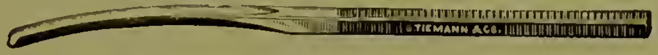

FIG. 527.—Stacke's gouge for removing the canal wall

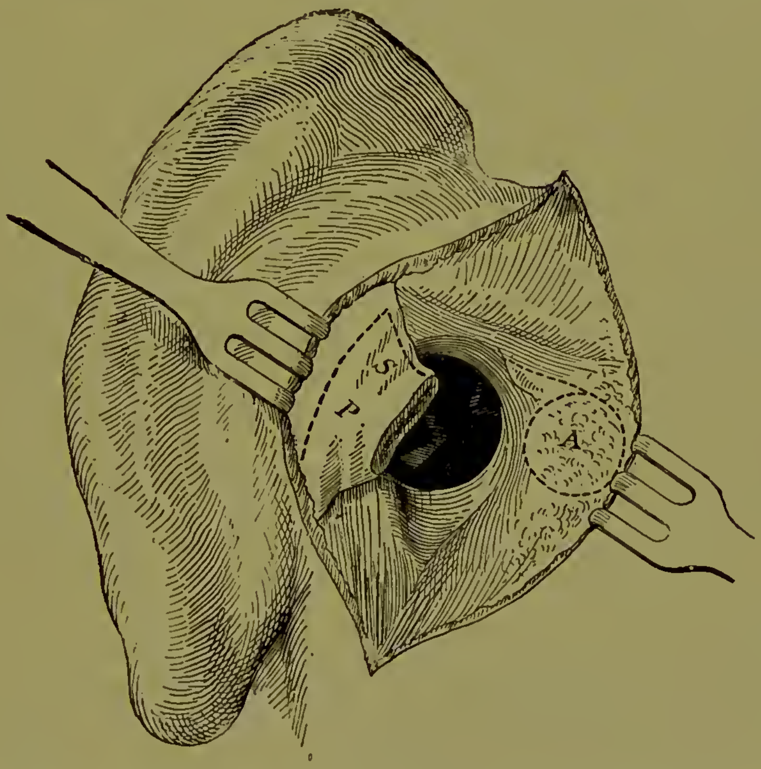

FIG. 528.—Auricle and cartilaginous canal turned forward for Stacke-Schwartze operation—the dotted lines at *A* showing the bone removed, and at *P*, *S*, the flaps to be transplanted into the gap (Vulpius). The writer makes but one flap without cutting at *P*, as do most operators.

it is unnecessary to remove it; the danger to the facial nerve is very great here. With cholesteatoma, after removing everything macroscopically pathological, Stacke grinds down the bone with burrs on an electromotor engine to remove any pathological masses in the Haversian canals. Lastly, if the cells of the mastoid toward the tip are involved, they should be cleaned out.

Finally, the last stage of the operation is to make a flap from the membranous meatus to cover the bone as far as possible. This is done by making a horizontal cut parallel with the axis of the meatus and along the middle of its upper wall from close to the concha to its inner end; perpendicular to this, close to the concha, make a second cut downward and backward so as to make a rectangular flap (Fig. 528). Now tampon tympanum, epitympanum, and aditus with small pieces of gauze, and then through the meatus tampon this rectangular flap to cover the bone between the meatus-wall and the floor of the antrum. The upper part of the wound is sutured into position and an aseptic dressing applied.

The final result by either method of operating is the same; the mastoid, antrum, aditus, tympanum, epitympanum, and meatus are turned into one large, continuous cavity with smooth walls which must become covered with a dry, firm epidermis. This epidermis can only grow from other epidermis which must extend inward from the external edges or be transplanted into the cavity. This transplantation can be by Thiersch grafts after the bone has become covered with small, firm granulations, and also by turning into the cavity a flap of skin taken from the outside; the latter implies a permanent opening behind the auricle. There is necessarily a large surface of exposed bone from the operation, and the more this can be covered at the time the quicker the healing and the less the risk of caries; and the more epidermis there is in the cavity the more rapidly will epidermization of the whole take place. Various methods of covering the bone and obtaining epidermis have been proposed. One is in the first exposure of the mastoid to cut down to the tip in front, then around the tip and upward at the posterior edge of the mastoid, then dissect up the skin alone and turn it upward for one flap; next dissect up the entire periosteum of the mastoid from above and turn it down for a second flap, so that after completion of the operation these flaps can be tamponed over the bone. Another is to turn in a flap of skin taken from the neck; while still another is to dissect up the skin behind the mastoid, to take from this place as large a flap of periosteum as is desirable to turn in, and then replace the skin against the bone, where it soon adheres. I have practised the first two methods with satisfaction. The last I have never used; it has the disadvantage of not supplying any of the desired epidermis.

Although the operation for cholesteatoma is the same as for caries, the surface affected by the growth requires special treatment; not only the whole investing membrane, if any, should be thoroughly curetted away, but the surface of the underlying bone should be as thoroughly curetted as its position admits to remove any growth in the Haversian canals. Zaufal advocates cauterizing it with a Paquelin cautery; Stacke uses an electromotor engine instead of the curette.

The after-treatment of the cavity is tedious, lasting from three to six months; the tamponing must be kept up till epidermization has covered the greater part of the cavity; it cannot be omitted till at least one of any two opposing surfaces are skin-covered. When, however, epidermization is well advanced, the omission of the tampons and exposure to the air will hasten

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the cure. Aristol and dermatol in powder are important aids to epidermization and to protect the young epidermis from maceration.

The tympano-mastoid exenteration, whatever method of performing it experience may finally determine to be best, seems to me destined to take an important position not only in the surgery of chronic otorrheas, but also in the surgery of the otitic brain-diseases.

The **otitic brain-diseases** are:

(1) Pachymeningitis externa purulenta, with extradural abscess;
(2) Leptomeningitis purulenta, or arachnitis;
(3) Phlebitis and thrombosis of the sinuses and of the jugular;
(4) Abscess of the brain, or encephalitis.

The brain-disease is due to infection of the brain from the infected ear, the infectious material reaching the brain through disease of the bone next the dura, through the natural communications which lead from the ear to the inside of the cranium, or through some of the tissue-connections, blood-vessels, or connective-tissue fibrils, which pass into and through the bone from both tympanum and dura. If the extension takes place through the roof of the temporal, the brain-disease is in the cerebrum; if through the inner wall, the brain-disease is in the cerebellum.

The following table of otitic diseases from Körner[1] has a most important bearing on the surgery of these diseases:

	Total.	Bone diseased to dura.	Bone diseased, but not to dura.	Bone healthy.
Sinus diseases . . .	39	32 = 82 per cent.	3 = 7.7 per cent.	4 = 10 per cent.
Brain-abscesses . . .	40	37 = 92 "	1 = 2.5 "	2 = 5 "
Meningitides. . . .	30	17 = 57 "	4 = 13.3 "	9 = 30 "
	109	86 = 79 per cent.	8 = 7.3 per cent.	15 = 13.7 per cent.

The tympano-mastoid exenteration, with modification for circumstances, in many cases is the best operation for these intracranial diseases; for as the ear is the original pus-focus, still active and still infecting, it should be the first point to attack. This is the only operation which exposes at once the entire roof of the antrum, aditus, and tympanum, and also the inner wall of the mastoid, thus allowing a thorough exploration of most of the spots whence transmission of infection to the brain occurs. It also allows the most perfect drainage by evacuating the pus at its most dependent position. In many cases, moreover, while we may feel confident of the existence of intracranial disease, we are unable to define its nature exactly; in other cases, while reasonably certain of our diagnosis of the brain-trouble, we cannot be sure of its exact location; again, in a very considerable proportion of cases the surgeon first sees the patient when the brain-disease is so active that time is more important than an accurate diagnosis. In all of these classes of cases a thorough exposure of the interior of the bone is the primary step for diagnosis, localization, and treatment; in this sense the operation on the bone is often exploratory. If any justification of this course is necessary, it is seen in the fact, shown in the table above, that in 79 per cent. of all otitic brain-diseases the bone is diseased directly upon the dura, and the operation on the bone means following the disease inward. I would emphasize this necessity of operating early in intracranial disease without waiting for an accurate diagnosis; for in a large number of cases the full complex of symptoms necessary for a perfect localized diagnosis only appears a few hours before death.

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[1] *Die Otitische Erkrankungen des Hirns, der Hirnhäute und der Blutleiter*, Frankfort, 1894.

Having performed the tympano-mastoid exenteration in a case showing brain-symptoms, disease of the bone next the brain should be sought by a careful examination of the whole superior and interior walls of the cavity. The diseased bone may be only a point not larger than the end of a probe; if found, it should be removed with curettes, and the opening enlarged by curettes or rongeurs.

With pachymeningitis externa (extradural abscess), pus is immediately evacuated and the dura cleansed. If the disease is in the middle fossa the only complications are arachnitis and brain-abscess; a fistula through the dura renders one or the other probable, and such a fistula should then be sought; if not found, the opening in the bone should be enlarged so far as the anatomical situation will allow, thorough drainage established by wicks of sterile gauze, and the wound dressed often enough to keep it free from collections of pus, usually daily. The dura becomes covered with granulations which adhere to the edges of the bone, and finally is covered by epidermization of the cavity.

Sinus-thrombosis.—If, however, the pachymeningitis is in the cerebellar fossa, besides the possibility of arachnitis and brain-abscess, phlebitis of the lateral sinus should be looked for, as it is a very common complication. It can usually be recognized by feeling the cord of a thrombus; but in case of doubt the sinus can be explored by aspiration, when we get purulent serum if the thrombus is broken down at the point of puncture, no fluid of any kind if the thrombus is firm, and venous blood if there is no thrombus. If thrombosis exists, the sinus should be exposed from its upper to its lower curve by removing the bone with curettes, rongeurs, or an engine, laid open freely, and the thrombus withdrawn both from behind and from below so far as it is broken down, and the vein cleansed. Hemorrhage from removal of the thrombus has never been reported, I believe; should it occur, it can be checked by a tampon of iodoform gauze. Before opening the sinus, however, the internal jugular had better be ligated to prevent displacement of thrombi and general infection; but the dangers of a prolonged operation or infiltration of the neck from a gravitation-abscess through the base of the mastoid, or from periphlebitis, may render this ligation inadvisable or impossible.

The following table from Körner is certainly in favor of the ligation:

Operations on the Lateral Sinus:

	Cured.	Died.	Total.
With ligation of jugular	26 = 63.4 per cent.	15 = 36.6 per cent.	41
Without ligation of jugular . . .	16 = 42 per cent.	22 = 58 per cent.	38
	42 per cent.	37 per cent.	79

	Cured.	Died.	Total.
Ligation before evacuation of sinus.	19 = 68 per cent.	9 = 32 per cent.	28
Ligation after " "	6 = 60 per cent.	4 = 40 per cent.	10
Ligation without " "	1 = 50 per cent.	1 = 50 per cent.	2
Ligation between beginning and end of evacuation	0	1	1
			41

Cause of Death of Above 37 Cases:

Pyemia with lung-abscesses	12
Pyemia without lung-abscesses	5
Leptomeningitis	11
Leptomeningitis and pyemia	3
Brain-abscess	2
Shock	1
Not determined	3
	37

If a fistula through the dura is found, arachnitis or brain-abscess is probable; to distinguish which is present is often impossible. If the former, the case is hopeless; if the latter, there is a possibility of cure. If the fistula is toward the cerebrum, the dura should be exposed over an extended surface, if possible, as large as 3 cm. in diameter, by cutting away, if necessary, the linea temporalis; if toward the cerebellum, by cutting away the posterior portion of the mastoid. The dura should then be opened by a crucial incision, and if the abscess has reached the surface, as is often the case, pus is immediately evacuated and the abscess can be freely opened. If only a small fistula is seen in the brain-tissue, or if no fistula is seen, the brain must be explored with a director. How deep this exploration can be carried without injuring specially important parts is of great consequence. These special parts are the anterior, inferior, and posterior horns, the lenticular nucleus, and the inner capsule; these can be avoided by confining the exploration to 2½ cm. (1 inch)[1] perpendicularly inward from the surface of the dura and 4 cm. (1½ inches) at an angle of 45 degrees with the surface; from the base of the brain upward the exploration can be carried to any distance, provided it is kept outside of 2½ cm. from the lateral surface.[2]

Exploration having proved the presence of an abscess, the exploratory puncture should be enlarged by tearing, the abscess thoroughly evacuated, drained by gauze wicks, and subsequent drainage provided for in the dressing.

In case of doubtful diagnosis or localization, this plan of following the disease inward by a tympano-mastoid exenteration or some modification of it is often best in my opinion; but it has its distinct limitations due (1) to the condition of the bone, (2) to the abscess lying beyond reach from the ear. Under the first we may have such a bony sclerosis or such a low roof and projecting Fallopian prominence or such an outward and forward curvature of the sigmoid groove as to forbid an opening sufficiently large for the brain-operation. Under the second are the very exceptional abscesses in the frontal or occipital lobes, abscesses in the upper convolution of the temporal lobe, and some abscesses of the cerebellum.

If the condition of the bone forbids the opening through the ear, bearing in mind the statistics which show that the chances are 80 in 100 the brain-disease is directly connected with the bone, any exploration should be close to the bone. To get at the mastoid and tympanic roof the skull may be opened at a point ½ cm. horizontally backward from a point 2 cm. above the upper edge of the osseous meatus, the dura opened and explorations made as already described. To get at the inner surface of the mastoid the posterior portion of that bone can be removed till the dura is fully exposed for at least 2 cm. behind the lateral sinus; explorations can then be made in the cerebellum in any direction to the depth of 3.5 cm. inside the lateral sinus. Another method of exposing the cerebellum, where the mastoid is so heavy or sclerosed as to make the above operation inadvisable, is to strike a basal line from the inferior osseous edge of the orbit to the occipital protuberance, and to open the skull on this line 5 to 7 cm. back from the edge of the osseous meatus, just below the superior curved line of the occipital bone.

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[1] Hansberg: *Archives of Otology*, Jan., 1895.

[2] Measurements for an adult brain.

Abscesses beyond reach from the ear can only be diagnosticated by a complete complex of localizing symptoms; where such a diagnosis can be made, the skull must be opened over the seat of this abscess. To reach the upper or first temporal convolution, enter the skull 2 cm. back from a point 3 to 3.5 cm. above the upper edge of the osseous meatus; to get at frontal or occipital abscesses, open over their seat as determined by previous localizing symptoms; for them no rules can be given.

I would here utter a caution about the dangers of the trephine, at least on the squamous portion of the bone, which varies very much in thickness in different parts, and the trephine may easily enter the brain at one part of its circumference some time before it has penetrated the bone in another part. In my opinion the only proper instruments are chisel and mallet, round burrs for thinning the inner cortex, and rongeurs to enlarge the first opening made.

Hesitation should always be felt in regard to opening the dura; it is justified only by the existence of a fistula in it or by urgent symptoms pointing to the encephalon, exclusive of arachnitis. Explorations can be carried to the dura with very little risk; it is a fibrous membrane not easily infected; but its incision exposes the arachnoid and pia, which are extremely sensitive to infection, and prolapse of the brain is very apt to follow withdrawal of the support afforded by the dura.

Where the ear cavities are not opened primarily, they must receive attention after the brain-operation, or at a subsequent operation it should never be forgotten that they are the original cause of the brain-disease.

THE NOSE AND THROAT.

NOSE AND THROAT.

ANATOMY OF THE UPPER AIR-PASSAGES, INCLUDING HISTOLOGY AND EMBRYOLOGY.

By HARRISON ALLEN, M. D., LL.D., and ARTHUR A. BLISS, A. M., M. D.,

OF PHILADELPHIA.

EMBRYOLOGY OF THE NOSE, PHARYNX, LARYNX, AND TRACHEA.

By Dr. Arthur Ames Bliss.

The Nose.—The development of the nose begins about the fourth week of fetal life.

On either side of the fore-brain the epiblast becomes thickened, and in the center of the *olfactory area* thus formed a depression appears, the *olfactory depression*. This assumes a pyriform shape, the larger opening external, the smaller extending backward as a groove toward the buccal invagination, where, very early, appear the rudiments of Jacobson's organ.

The rudimentary base of the nose, the *fronto-nasal process*, appears in the median line at the lower margin of the fore-brain (Fig. 529). A depression exists in the center of this process, and on either side of the depression are the *mesial nasal processes*, their bases being united to the fronto-nasal process, while their free margins terminate in tubercles—the *globular processes*. These eventually approach one another until they unite in the median line and form the intermaxillary process and middle portion of the upper lip. A depressed surface is left between them, and from this is formed the

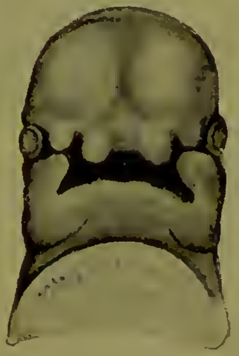

Fig. 529.—Head of human embryo, showing above the oral cavity the fronto-nasal and mesial nasal processes (His).

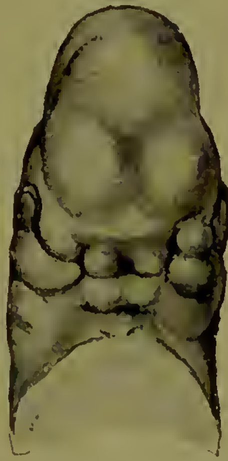

Fig. 530.—Head of an embryo, showing the development of the lateral nasal processes (His).

lower part of the nasal septum. During this development the globular processes extend backward, also bordering the space which will become eventually the roof of the mouth (Fig. 530). This backward extension constitutes the nasal laminæ, by the development of which the nasal septum is completed. Two processes, the *lateral nasal processes*, with bases attached to the fore-brain on either side, external to the fronto-nasal process, grow forward around the olfactory depressions, unite in the median line, and form the alæ nasi. In their development they meet the *maxillary processes*, also growing forward to the median line, and between the maxillary processes and the lateral nasal processes is found a groove on either side of the head, extending from the eye to the nose—the lacrymal groove. The maxillary processes as they approach one another come in contact and unite with the free ends of the globular processes, a junction which, together with the *intermaxillary process*, forms the lip and upper jaw, thus making the division between the anterior part of the nasal passage and the buccal cavity (Fig. 531). Posterior to this now closed anterior part, the olfactory depressions still open into the mouth; but from the outer sides of these depressions processes are thrown out (Fig. 531) which develop into the turbinal bodies, while gradually the developing palatine processes of the superior maxilla, outgrowths from the embryonic maxillary processes, approach the lower part of the nasal septum, and unite with it and with one another to form the roof of the mouth and floor of the nose. The nares and buccal cavity are thus separated from one another (Fig. 532), except in the extreme posterior part of the nasal passages, where, in the naso-pharynx, is found the free opening from the nares to the oro-pharynx.

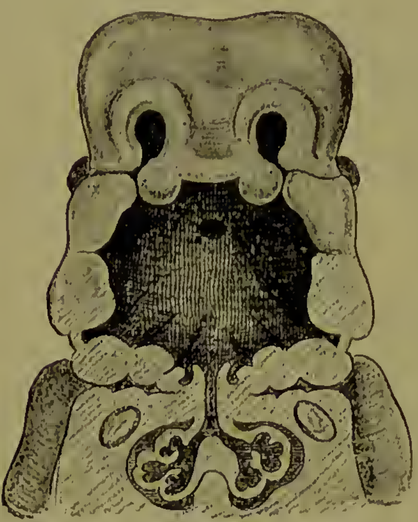
Fig. 531.—Head of embryo, partly sectioned to show the beginning palatal processes growing inward (His).

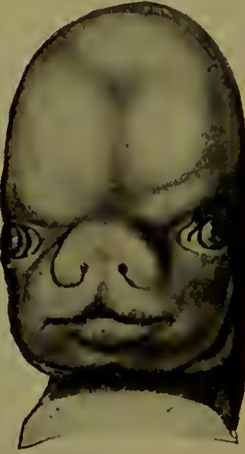
Fig. 532.—Head of embryo, showing the completed union of the constituents of the nose and lip (His and Quain).

The Mouth, Pharynx, Larynx, and Trachea.—In the process of evolution of the embryo from the blastoderm the three embryonic layers gradually enfold three distinct cavities, called the fore-gut, the hind-gut, and, between them, a space which long remains in free communication with the yolk-sack. The cephalic portion of the embryo is bent at a right angle around the anterior part of the fore-gut. Below, the latter is bounded by the heart. A thin epithelial membrane separates the fore-gut from the involution of the epiblast which forms the buccal cavity, or *stomodæum*. This deepens, projecting upward into the angle between the fore- and mid-brains, where the pituitary body is formed; the epithelial septum between the buccal cavity and the fore-gut disappears; and the process of development already described in treating of the growth of the nose completes the formation of the face and mouth. The anterior part of the fore-gut, the area of the pharynx, enlarges, and the hypoblastic layer throws out four projections on either side in order from above downward. Opposite these outgrowths the epiblastic layer projects inward, and four clefts in the pharyngeal wall are thus formed, the *cephalic visceral clefts.* About them the pharyngeal wall thickens into five curved ridges, the *cephalic visceral arches.* A forked elevation termed the *furcula* separates the second and third visceral arches (Fig. 533). A groove passes through its center, and immediately in front of this, in the receding angle between the two arms of the second arch, a tubercle projects, the *tubercle impar* (see Fig. 533). The second and third arches coalesce at their receding angles to form one mass with four projecting arms. The latter grow forward into a V-shaped projection, enclosing the tubercle impar and uniting into one mass to form the tongue. The epiglottis is developed from the furcula, and from it also develop the ary-epiglottic folds and arytenoid cartilages. The groove seen in its center extends to the entrance of the larynx.

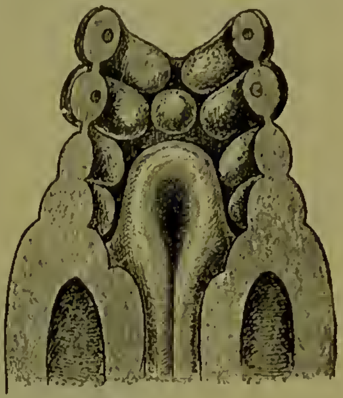
FIG. 533.—Posterior aspect of the visceral arches as seen from the interior of the pharynx (His).

Of the visceral clefts the first, called the hyomandibular cleft, is an important element in the formation of the Eustachian tube and middle ear. The median base of the branchial rudiments gradually separates from the esophagus, serving as a partition-wall between the latter and the larynx and trachea.

ANATOMY OF THE NASO-PHARYNX, PHARYNX, LARYNX, AND TRACHEA.

The Pharynx.—The pharynx is the common entrance to the respiratory and digestive tracts. For purposes of description and, also, clinically, it may be divided into three distinct areas—the naso- or rhino-pharynx, the oro-pharynx, and the laryngo-pharynx (Fig. 536).

The **rhino-pharynx** lies immediately posterior to the nasal chambers or posterior nares. It is slightly quadrilateral in shape, its transverse diameter measuring about one and three-eighths inches, while its antero-posterior and vertical diameters are about three-quarters of an inch.

In front it is bounded by the two oval openings of the posterior nares, with the rear margin of the vomer in the median line (see Figs. 535 and 562). This margin is thin below, but widens into two lateral arms or wings above, where the vomer is attached to the body of the sphenoid bone. The upper surface of the naso-pharynx or vault is formed by the basilar process of the occipital bone and a portion of the body of the sphenoid bone (see Fig. 434). On either side it is flanked by the pharyngeal openings of the Eustachian tubes (see Figs. 451, 562). Its floor is formed by the soft palate and by the opening into the oro-pharynx.

The mouths of the Eustachian tubes present prominent projections on either side of the naso-pharynx, formed mainly from the cartilage of the tube. The orifice of each tube lies about on a plane with the posterior margin of the vomer. Its exact position varies in different subjects. A well-defined ridge of cartilage roofs the tube and forms its posterior lip. The ridge is less prominent in front than above and behind the Eustachian opening. It is not seen below the orifice. The mucous membrane of the naso-pharynx forms a distinct fold where it is reflected over the posterior lip of the tube and passes thence to the pharynx. Luschka terms this fold the *plica salpingo-pharyngea.* A similar fold, less marked however, extends from the anterior lip of the tube to the soft palate, termed by Luschka the *plica salpingo-palatina.* A crescent-shaped depression is seen immediately behind the posterior lip of the Eustachian opening—the *fossa of Rosenmüller.* It is of considerable clinical importance, as it is a valuable guide in the introduction of a catheter into the Eustachian opening. The Eustachian openings, closed during a state of rest, are opened by the contractions of the *tensor* and *levator palati* muscles. The tensor muscle, termed also the *spheno-salpingo-staphylinus,* or dilator muscle, arises from the scaphoid fossa and base of the internal pterygoid plate of the sphenoid bone, and from the front of the entire cartilaginous portion of the Eustachian tube. Its fibers pass downward, winding around the hamular process of the sphenoid bone, and are inserted in the soft palate. Its contraction dilates the tube by drawing the anterior margin of its cartilage and the membranous front wall downward and forward (see Fig. 450). The *levator palati* muscle arises from the petrous portion of the temporal bone and from the cartilaginous part of the Eustachian tube. Its fibers are inserted by a broad tendon into the median line of the soft palate (Fig. 535). Its function is to lift the lower wall of the Eustachian tube, which tends to separate the lateral walls and open the tube. The *palato-pharyngeus* muscle, described later, is also partially attached to the cartilaginous part of the Eustachian tube. It acts as an aid to the levator palati muscle.

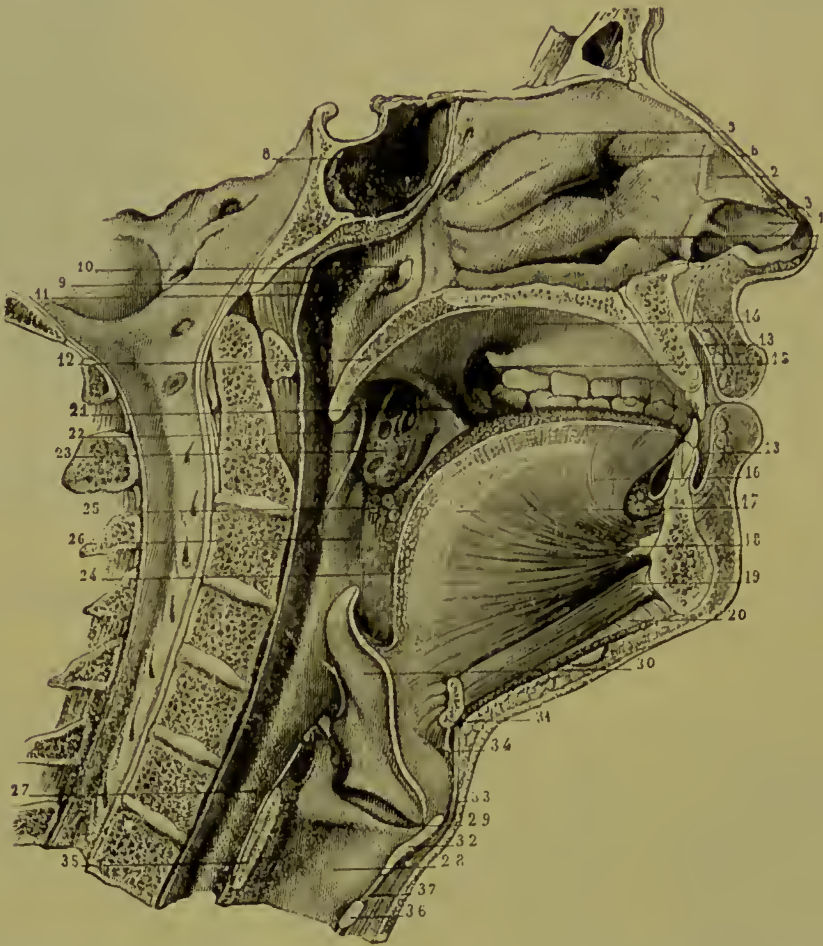

FIG. 534.—Sagittal section of the head and neck, showing the upper air-passages, beginning at the nostril (1), including the superior (5), middle (6), and inferior (7) nasal meatus beneath the corresponding turbinals, the sphenoid sinus (8), the Eustachian tube (10), the rhino-pharynx and Rosenmüller's fossa (11) above the soft palate (12), the oro-pharynx (26), and fauces (22), and the laryngo-pharynx (27). The trachea is not shown below the cavity of the larynx (28) with its ventricle (29) bordered by the vocal cord below and the ventricular band above. The relation of the epiglottis (30) to the larynx below it and the hyoid bone (31) in front is well shown; but the tongue (17) really fills the mouth normally and lies in contact with the soft and hard palate (14), the uvula (21) reaching to the epiglottis, as the mouth is not properly a part of the air-passages (Leidy).

The covering of the naso-pharynx consists of mucous membrane richly supplied with mucous glands and having a covering of columnar ciliated epithelium. Beneath the mucous membrane lies a dense fibrous aponeurosis, which is the upper part of the general pharyngeal aponeurosis. It is firmly attached to the basilar process of the occipital bone and to the petrous portion of the temporal bone.

In certain subjects suffering from sclerotic or atrophic rhinitis, a well-defined ridge is seen to project from the posterior and lateral walls of the naso-pharynx about at the level of the free margin of the soft palate. Acting with the palate, when the latter is raised, this ridge becomes very prominent, "Passavant's cushion," and helps to close the opening from the naso- to the oro-pharynx, as strings pucker up and close the mouth of a purse.

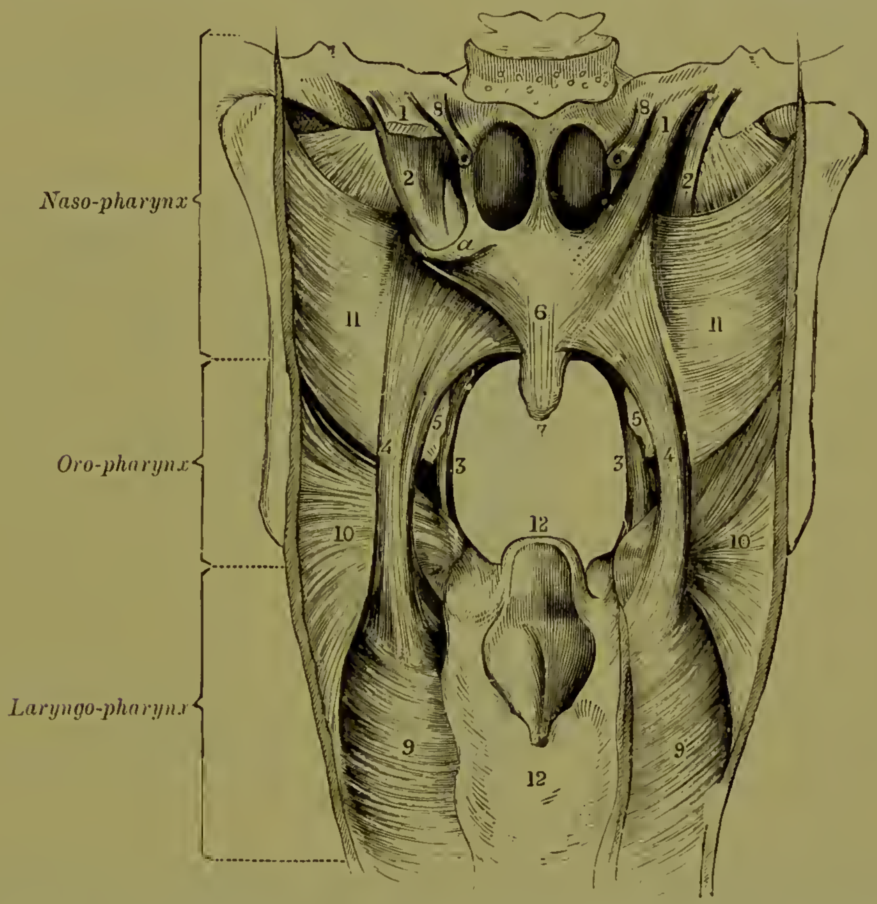

FIG. 535.—Pharynx from behind, showing its muscles. The levator palati (1) is seen to arise beneath the Eustachian tube (8), to be inserted into the velum, as is the tensor (2) after hooking around the hamulus at *a*. The palato-glossus (3) and the palato-pharyngeus (4) form the anterior and posterior pillars enclosing the tonsils (5), and the azygos (6) passes down upon the uvula (7). The inferior (9), middle (10), and superior (11) constrictors of the pharynx are shown partially, and the posterior nares, the oral cavity (normally filled by the tongue), and the larynx (12) (Browne).

Its existence often interferes with the escape of secretions downward from the naso-pharynx, and thus causes their retention and crust-formation at this point. This ridge is caused by the prominence of the contracting upper fibers of the superior constrictor muscle of the pharynx as they pass downward and backward along the free superior margin of the muscle from its wide attachment above to the median line of the pharyngeal aponeurosis.

The **lymphoid structure** in the naso-pharynx is of great clinical importance. This tissue is a part of "the lymphoid ring" of the pharynx. It is located in the center of the superior and posterior walls of the naso-pharynx, and spreads laterally on either side to the recesses above the lips of the Eustachian openings and even into the fossæ of Rosenmüller. Normally, it is about one-fourth of an inch in thickness, and should not cause occlusion of the naso-pharyngeal space or pressure upon the Eustachian opening. In structure it is a collection of lymph-follicles, or adenoid tissue, held together in a loose fibrous network of connective tissue and covered with mucous membrane having columnar ciliated epithelium. In rather rare instances an opening is observed leading to a closed sac in the center of the mass, termed the *bursa pharyngea.* Its very existence as a normal structure has been questioned by many writers. When present it is doubtless an abnormal phase of development (see page 949).

The **blood-supply** of the naso-pharynx comes through the ascending pharyngeal artery, a branch of the external carotid; through the ascending palatine, a branch of the facial; and through the spheno-palatine, a branch of the internal maxillary (see Fig. 549).

The veins pass into the internal jugular vein.

The nerve-supply comes from the superior maxillary nerve (second branch of the fifth nerve) and from the pneumogastric and glosso-pharyngeal nerves.

The Oro-pharynx and Laryngo-pharynx.—The *oro-pharynx* may be said to extend downward from the projection on the posterior wall of the pharynx caused by the tubercle on the anterior arch of the first cervical vertebra. An imaginary line from this point to the base of the uvula serves as a dividing-line between the naso- and oro-pharynx (Fig. 534). We shall refer to the oro- and laryngo-pharynx as the pharynx proper. It is quadrilateral in shape, its antero-posterior diameter being much more narrow than its transverse. Its anterior wall extends from the base of the uvula and the free margin of the soft palate downward across the oral cavity to the posterior extremity of the greater horn of the hyoid bone. Its posterior wall extends from the tuberosity on the anterior arch of the first cervical vertebra to the orifice of the esophagus. Its lateral walls are in relation with the common and internal carotid arteries, the internal jugular vein, the sympathetic nerve, and the eighth and ninth cranial nerves.

In general structure the pharynx is a musculo-membranous sac consisting of three layers, an inner mucous membrane, a middle fibrous layer, and an outer layer of muscular tissue.

The *mucous membrane* of the pharynx is thin, and in the naso- and oro-pharynx adheres closely to the fibrous layer beneath it. Like the mucous covering of the alimentary tract in general its epithelial layer consists of squamous cells. As the pharyngeal vault is approached the epithelium changes more and more to the type found in the respiratory tract, and, in the purely respiratory tract of the naso-pharynx, it becomes columnar and ciliated. Two varieties of glands are found in the pharyngeal mucous membrane. One, the ordinary muciparous gland, exists in greatest number in the oro-pharynx and upon the soft palate. The glands of the second variety lie deeper in the mucous membrane and belong to the lymphoid type. These ductless follicles are scattered irregularly throughout the mucous membrane, but exist in greatest number along the lateral surfaces of the pharyngeal wall, lying closely behind the so-called posterior faucial pillars.

The *fibrous layer of the pharynx,* or pharyngeal aponeurosis, external to the mucous membrane is, in the upper pharyngeal region, very dense in structure; but in the laryngo-pharynx it becomes thinner, until it is scarcely to be traced at the entrance of the esophagus. In the naso-pharynx it adheres closely to the basilar process of the occipital (Fig. 536).

The *muscular coat of the pharynx,* its third and deepest layer, consists of three flat *constrictor* muscles, so arranged as to form a sheath around the posterior and lateral walls.

The *superior constrictor muscle* arises from the lower portion of the margin of the internal pterygoid plate and from its hamular process, from the portion of the palate-bone adjacent and from the reflected tendon of the tensor palati muscle, from the pterygo-maxillary ligament, from the alveolar process of the superior maxilla above the posterior extremity of the mylo-hyoid ridge, and from the sides of the tongue, where a few fibers of the superior constrictor are in connection with the genio-hyoglossus muscle. From this very widely-distributed attachment the fibers of the main body of the muscle curve backward to be attached to the raphé in the median line of the pharyngeal aponeurosis. The superior fibers curve backward and upward, blending with the fibrous aponeurosis which covers the pharyngeal vault, and is attached to the pharyngeal spine of the occipital bone. The projecting ledge caused by the free upper margin of this muscle, already mentioned, assists in closing the naso- from the oro-pharynx, and is of clinical importance in some cases of atrophic rhinitis. The superior constrictor is quadrilateral in form, and its fibers are thinner than are those of the middle and inferior constrictors. Its inferior fibers are partially overlapped by the upper fibers of the middle constrictor.

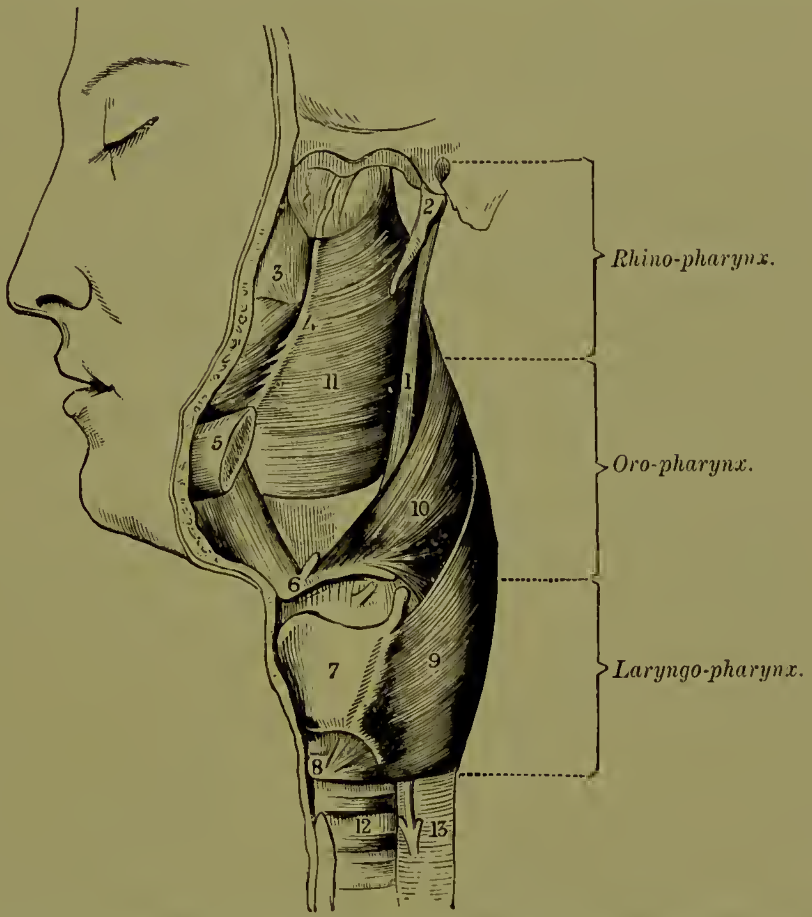

FIG. 536.—Lateral view of the pharynx, larynx, and esophagus, showing the superior (11), middle (10), and inferior (9) constrictors, arising from the pterygo-maxillary ligament (4), the hyoid bone (6), and the larynx (7), respectively, to pass back to the posterior raphé. The arrangement of the fibers clearly suggests the action of the superior constrictor in closing off the rhino-pharynx before deglutition through action of the lower constrictors.

The *middle constrictor*, arising from the greater and lesser horns of the hyoid bone and from the stylo-hyoid ligament, is a fan-shaped muscle, its fibers passing up, back, and down to the median raphé.

The *inferior constrictor*, the largest of the three, arises from the thyroid and cricoid cartilages, its attachment to the thyroid being at the inferior cornua and along the oblique lines on the sides of the alæ and on the surfaces immediately behind these lines, almost as far as the posterior borders. From the cricoid cartilage it arises in the interval between the crico-thyroid muscles in front and the facet for the crico-thyroid articulation behind. The fibers pass backward and slightly upward, and are attached to the raphé in the median line of the pharyngeal aponeurosis, the ascending fibers overlapping the lower fibers of the middle constrictor, while the lower fibers blend with the circular muscular fibers of the esophagus. Beneath the constrictor muscles are found the *longus colli* and the *rectus capitis anticus muscles*, with the cervical vertebræ beyond.

The three constrictor muscles are the chief elements in the formation of the muscular layer of the pharynx. Certain other muscles, however, contribute to the formation of this muscular coat, and are classified among the muscles of the pharynx. These are the *stylo-pharyngeus*, the *palato-glossus*, the *palato-pharyngeus*, and the *stylo-hyoid*.

The *stylo-pharyngeus* (see Figs. 535, 536) is a long, narrow, muscular band, round and cord-like above, where it arises from the inner side and base of the styloid process, but flattened and widened as it descends by the side of the pharynx, passing between the superior and middle constrictors. Most of its fibers terminate beneath the mucous membrane of the pharyngeal wall, some merging with fibers of the constrictor muscles. Other fibers descend farther and are inserted into the thyroid cartilage on its posterior border.

The *palato-pharyngeus* muscle (see Figs. 534, 535) is a broad thin band, widening as it descends, apparently from the base of the uvula, and passes down and back, to be lost in the lateral pharyngeal walls. It forms with the covering mucosa the "posterior pillar of the fauces." Its superior origin is by two fasciculi in the soft palate, joining their fellows of the opposite side in the median line. It is inserted with the stylo-pharyngeus into the posterior border of the thyroid cartilage. A few of its fibers spread along the sides of the pharynx and cross the latter to join, in the median line, those from the opposite side.

The *palato-glossus muscle* (see Figs. 534, 535) forms the so-called "anterior pillar of the fauces." It is a narrow fibrous band, narrower and thinner than the palato-pharyngeus muscle, or "posterior pillar." Its upper attachment is the anterior surface of the soft palate. It passes in front of the tonsil downward, forward, and outward, and is inserted into the sides and back of the tongue.

Blood-supply of the Pharynx.—*Arteries.*—The ascending pharyngeal arteries, branches of the external carotid, supply the constrictor muscles and the mucous membrane. They may be of abnormal size, not rarely so large as to cause a distinct pulsation on one or both sides of the pharynx, just behind the posterior faucial pillars.

The Vidian and descending palatine arteries, branches from the internal maxillary artery, also supply the pharyngeal tissues, as do branches from the facial, the tonsillar, and ascending palatine arteries.

Veins.—A thick network of veins is found in the fibrous layer of the pharynx, forming the pharyngeal plexus in the posterior and lateral walls. From these the blood is led by the pharyngeal vein into the internal jugular.

Lymphatics.—The lymph-vessels follow the course of the pharyngeal plexus and veins and enter the chain of lymphatic glands along the sheath of the carotid, terminating on the right side in the right ductus lymphaticus; on the left in the thoracic duct.

Nerves.—The sensory nerves of the pharynx come from the glosso-pharyngeal. The motor nerves are derived from the glosso-pharyngeal and pneumogastric. These, with the sympathetic, unite to form the pharyngeal plexus.

Lymphoid Structure of the Pharynx.—Reference has been made already to the ductless follicles in the pharyngeal mucous membrane and to their special seats of location on the lateral and postero-lateral walls of the pharynx.

At certain points in the pharynx are found conglomerate masses of lymphoid tissue, forming a continuous "lymphoid ring" around the entrance to the alimentary and respiratory tracts.

The upper segment of this ring is formed by the adenoid tissue of the naso-pharynx, or "pharyngeal tonsil," already described; the lateral segments are formed by the "faucial tonsils," and the lower segment by the lymphoid tissue found at the base of the tongue, "the lingual tonsil." The *faucial tonsils* are small oval or almond-shaped masses of lymphoid tissue, placed within the somewhat triangular space between the palato-pharyngeal and the palato-glossal muscles. In the normal condition they are about three-quarters of an inch in vertical length by one-third of an inch in breadth. Even within normal limits, however, there is great variation in size. The free surface of each faucial tonsil is marked by numerous round or slit-like openings, arranged in two or more parallel columns, or more irregularly, which lead down into invaginations of the surface called crypts. This peculiar structure is claimed by Retterer to be the result of an ingrowing of the epiblastic membrane into the hypoblast. The epithelial elements are thus forced into a lymphoid mass, and the latter grows around the invaginations or into their walls, breaking up their outline into small, lateral pockets. The diverticula, as Harrison Allen terms the lymph-follicles, are thus in the faucial tonsils arranged in groups which occasionally sink below the general surface of the mass, thus forming the crypts.

The *lingual tonsil* occupies the base of the tongue, being placed between this and the epiglottis. It is a smooth, soft, even mass of lymph-follicles, the diverticula of which, as Allen states, are single and not in groups.

The covering of both the faucial and lingual tonsils consists of the pharyngeal mucous membrane. In many instances, however, this is underlaid by bands of fibrous tissue which more or less fully encapsulate the lymphoid masses.

The faucial tonsil is in rather close relation with the internal and external carotid arteries, the internal jugular vein, and the pneumogastric nerve. These structures, however, pass through the posterior portion of the pharyngo-maxillary interspace, while the faucial tonsil occupies the anterior part of this space: thus they are safely beyond the reach of any cutting instruments which are used with skill and care in operations upon the tonsils.

The *blood-supply* of the faucial tonsil comes from the facial artery by the tonsillar and ascending palatine; from the lingual artery by the dorsalis linguæ; from the external carotid by the ascending pharyngeal; and from the internal maxillary by the descending palatine branch. The most important artery is the tonsillar, springing from the facial artery. It is a small vessel in children, but in adults is of more important size. It is not apt to be wounded during cutting operations upon the tonsils, unless such procedures involve the base of these masses.

The *veins* center into a plexus, named the tonsillar plexus. The nerves are from the fifth nerve and the glosso-pharyngeal nerve.

The Larynx.—The larynx forms the entrance to the respiratory tract and is, at the same time, the organ for the formation of the voice. Its function of voice-production depends largely upon the vocal cords, and the general structure of the larynx is designed to protect these and to give attachment to the muscles controlling their movements.

The Cartilages.—The framework of the larynx (Fig. 537) consists of the thyroid, the cricoid, and the two arytenoid cartilages, composed of true cartilage; and of the two corniculæ laryngis (cartilages of Santorini), the two cuneiform cartilages (cartilages of Wrisberg), and the epiglottis, all fibro-cartilaginous in structure. Above the larynx, and at the base of the tongue, which is attached to it, lies the hyoid bone (Figs. 537, 538). The hyoid bone (from the Greek υ-shaped), besides its important relation to the tongue and its function in serving to stretch the pharynx in its lateral diameter, serves also to give a point of fixation above to the larynx. It consists of a central body with two greater and two lesser cornua. The body is quadrilateral in form, convex on its anterior surface, concave posteriorly. It supports the two lesser cornua which project upward and backward from its superior and lateral margins. From these lateral margins beneath the lesser cornua extend backward the greater cornua, completing the half-circle. From the hyoid bone muscles and ligaments pass to the epiglottis and to the thyroid cartilages, uniting it with these structures.

The *thyroid cartilage* (Fig. 537) (from the Greek, a shield) consists of two curved quadrilateral plates, converging anteriorly to meet in the median line, and forming a projecting angle somewhat like the prow of a ship. This angle is a prominent feature in the neck (see Fig. 534), especially in the adult male (the "Adam's apple"), standing boldly outward beneath the integument, from which occasionally it is separated by a bursa. The upper margin of each side, or *ala*, of the thyroid curves downward at this point of junction, forming the thyroid notch, resembling the spout of a pitcher; and backward each descends slightly to rise abruptly at the posterior limit into a long process, pointing upward, called the superior cornu (Fig. 538). The prominent anterior angle of the thyroid is slightly concave below the thyroid notch. The lower border of each ala curves backward and generally downward and forms the lesser cornu. The posterior, free borders of the thyroid, which are rounded and thick, thus terminate, above in the greater, below in the lesser, cornua. An oblique ridge passes downward and forward across the outer surface of each ala of the thyroid, starting from a tubercle near the base of the superior cornu, and gives attachment to the sterno-thyroid and thyro-hyoid muscles. Back of this ridge, and including the surface to the posterior margin of each ala, is the long narrow area of attachment of the inferior constrictor muscle of the pharynx, while to the center of the posterior margin is attached the stylo-pharyngeus muscle.

The inner surface of each ala is concave, and covered in the upper and posterior portions with mucous membrane. In the receding angle anteriorly, where the two alæ unite immediately below the thyroid notch, the thyro-epiglottic ligament forms the attachment of the epiglottis, and just below this, on either side, are the anterior points of attachment for the ventricular bands, or false vocal cords (Fig. 539). The true vocal cords, together with the thyro-arytenoid muscles, have their anterior points of attachment immediately beneath these in the lower third of this receding angle. The lower margins of the thyroid cartilage, in their anterior and lateral aspects, give attachment to the crico-thyroid membrane and to the crico-thyroid muscle.

The *cricoid cartilage* (from the Greek, a ring) lies immediately below the thyroid (Figs. 537, 538, 540). Its anterior half is small, narrow, rounded, and convex in shape. Its superior margin rises as it extends backward, causing the cartilage to broaden toward its posterior portion, which is almost thrice as broad, in a vertical direction, as is the anterior; while it is at the

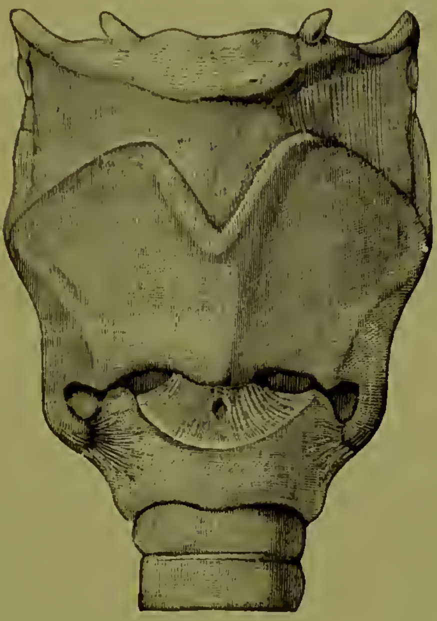

FIG. 537.—Larynx, showing the thyroid and cricoid cartilages, with the trachea below and the hyoid bone above, with the connecting membranes (Leidy).

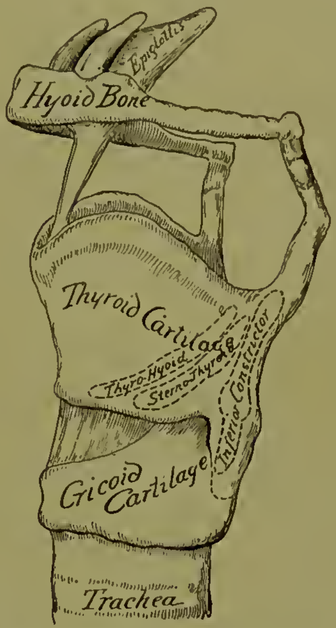

FIG. 538.—Lateral view of larynx in its relation to the hyoid bone and trachea.

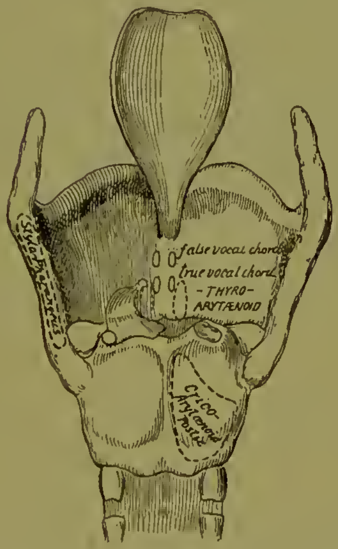

FIG. 539.—Inner aspect of larynx from behind, showing insertions of epiglottis, true and false cords, and of the intrinsic muscles.

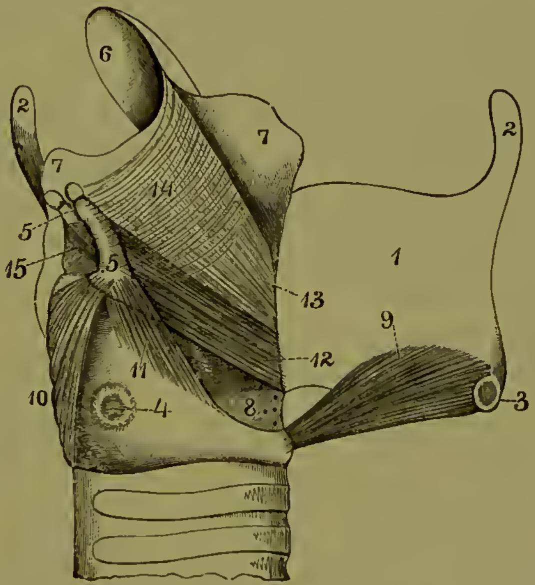

FIG. 540.—Larynx dissected to show the muscles: the crico-thyroid (9) inserted on the inner aspect of the ala to the articulation (3); the posterior crico-arytenoid (10) inserted at the base of the arytenoid (5); behind the lateral crico-arytenoid (11); the thyro-arytenoid (12) just below the position of the vocal cord; the thyro-epiglottic (13) and aryteno-epiglottic (14) fibers between the lamina of the aryepiglottic fold; and the arytenoid (15) between the arytenoid cartilages (Leidy).

same time greatly increased in thickness. On the outer lateral surface of this posterior "seal" portion of the ring are facets, one on either side, for articulation with the lesser cornua of the thyroid cartilage. On its upper surface in this posterior half are two facets, their long diameters transverse, for articulation with the arytenoid cartilages. In the median line of the broad posterior border of the cricoid is a vertical ridge for the attachment of the esophagus, with broad points of attachment on either side for the posterior crico-arytenoid muscles. The outer surface of the cricoid anteriorly gives attachment to the crico-thyroid ligament and to the crico-thyroid muscle and to the lateral crico-arytenoid muscle.

The cricoid forms the back of the larynx, as well as its lower portion, and is the base upon which the other cartilages of the larynx rest.

The *arytenoid cartilages* (ὀ, a pitcher) (Fig. 539) are two pyramidal cartilages which articulate with the upper margin of the thick posterior portion of the cricoid. They might be called the cartilages of the vocal cords, as the vocal cords, together with all the muscles controlling their movements (with the exception of the crico-thyroid), are attached to the arytenoids. They present three surfaces, a base, and an apex for study. The inner surface of each cartilage, covered with mucous membrane, is smooth, flat, somewhat triangular in shape, for apposition to the corresponding side of its fellow. The anterior surface is convex and gives attachment to the ventricular bands and the thyro-arytenoid muscle. The posterior surface is concave and triangular in shape and gives attachment to part of the arytenoid muscle. The base is concave for articulation with the corresponding convex facet on the cricoid, and is marked by two projections or processes terminating its external and anterior angles. The longer of these is the anterior, called the *vocal process*, as to it the vocal cord is attached. The rounded external process is named the *muscular process*, and upon it are inserted the posterior and the lateral crico-arytenoid muscles. The apices of the arytenoids are pointed and curve backward and inward. Each apex is crowned by a small nodule of cartilage, serving to lengthen it slightly, called the *cornicula laryngis*, or cartilage of Santorini. To these nodules are attached the aryteno-epiglottidean folds, in which, close to the outer side of each cartilage, are embedded the two small cartilages of Wrisberg, the cuneiform cartilages. They are sesamoid in character and vary greatly in size in different individuals. Two sets of sesamoid cartilages are also found occasionally, the posterior and anterior sesamoid cartilages. When present, the posterior sesamoids lie between the apices of the arytenoids and the cartilages of Santorini; the anterior are found in the extreme anterior end of the vocal cords, being attached to the receding angle of the thyroid cartilage.

The *epiglottis* (see Figs. 538 and 539), named from its position above the glottis, is the cover of the larynx. It is an oblong, leaf-shaped plate of fibro-cartilage, its upper border rounded, its lower somewhat pointed and attached by a long thyro-epiglottic ligament to the receding angle of the thyroid cartilage immediately below the thyroid notch. The mucous membrane covering the anterior surface toward the base of the tongue is reflected to the sides and base of the cartilage in two folds, the *glosso-epiglottic ligaments*. The anterior surface curves forward slightly toward the tongue, but the position varies greatly in different subjects. The posterior surface, transversely concave but vertically rather convex, faces somewhat downward over the laryngeal entrance and is covered with mucous membrane, which at its base is thickened by the presence of adenoid tissue into a smooth, slightly prominent elevation termed the *cushion of the epiglottis*. Its free margin is rounded, or, especially in children, is narrowed into a curve, with the concavity downward, rendering, when in this form, a view of the interior of the larynx somewhat difficult, as the epiglottis is apt then to be more depressed than when this upper margin is broad and flattened. The epiglottis is also connected with the body of the hyoid bone on the posterior surface of the latter by a ligamentous or elastic band, the *hyo-epiglottic ligament*. The aryteno-epiglottic folds are attached to the sides of the epiglottis. Numerous pits, or depressions, are found in the body of the cartilage of the epiglottis, in which lie small mucous glands. The epiglottis being freely movable varies in position during respiration and deglutition. During respiration it maintains a somewhat vertical direction, its free margin being curved toward the base of the tongue. In the act of deglutition, however, as the larynx rises, the epiglottis is carried upward against the base of the tongue and its free margin is greatly depressed, so as to serve as a cover to the entrance of the larynx.

Ligaments of the Larynx.—The thyroid cartilage is bound to the hyoid bone by three ligaments, the two *lateral thyro-hyoid ligaments*, narrow, rounded bands of fibro-elastic tissue, attached to the extremities of the superior cornua of the thyroid cartilage and extending upward to the greater cornua of the hyoid bone; also, the *thyro-hyoid membrane*, a broad, fibro-elastic membrane, attached below to the upper border of the thyroid cartilage, and above to the posterior face of the body of the hyoid bone. The superior laryngeal nerve and vessels pass through the median line of this membrane.

The thyroid and cricoid cartilages are bound together by three ligaments, the *crico-thyroid membrane* and two *capsular ligaments* (see Fig. 537). The crico-thyroid membrane, triangular in shape, passes from the superior margin of the cricoid cartilage in the median line and from both sides anteriorly, and is inserted in the lower border of the anterior part of the thyroid cartilage. Thick in the center, it becomes thinner on either side, and these lateral portions are joined at their insertion with the insertion of the true vocal cords. In the median line the crico-thyroid membrane lies directly beneath the skin, and thus offers a ready means for effecting an artificial opening into the larynx. At this point the membrane is crossed by an anastomosis of the two small crico-thyroid arteries. It is covered on its inner surface with mucous membrane. The lateral portions of the crico-thyroid membrane are covered by the crico-thyroid muscle and the lateral crico-arytenoid muscles.

The capsular ligaments between the cricoid and thyroid cartilages bind the inferior or short processes of the thyroid to the cricoid cartilage at their points of articulation.

The arytenoid cartilages are held to the cricoid cartilage by loose *capsular ligaments*, also posteriorly by the small *posterior crico-arytenoid ligaments*.

The epiglottis is bound to the hyoid bone by two ligamentous bands which extend from the sides of the cartilage, near its apex, the *hyo-epiglottic ligaments*, and to the thyroid cartilage by the *thyro-epiglottic* ligament already described.

The *median glosso-epiglottic* folds of mucous membrane unite the epiglottis to the base of the tongue.

Interior of the Larynx (Fig. 541).—The general shape of the laryngeal opening is triangular with the base posterior. Looking from above into the larynx the free margin of the epiglottis is first seen, a curving surface which varies in the degree of its curvature in different subjects. Beneath, and posterior to the inner face of the epiglottis, appear the apices of the arytenoid cartilages, the small cartilages of Santorini at the apex of each, the smooth rounded swelling on the outer side of both arytenoids, paler than the red of the general mucous covering, showing the location of the cartilages of Wrisberg. These are seen to lie each in the body of a broad prominent fold, which passes in a half-circle framing the sides of the laryngeal opening, one on each side, from the arytenoid cartilages upward to the side of the epiglottis. These are the aryteno-epiglottic folds. Below the level of the apices of the arytenoid cartilages, two bands, covered, like the tissue already named, with mucous membrane, pass from the arytenoids forward to the receding angle of the thyroid cartilage, terminating there beneath the attachment of the epiglottis. These are the *ventricular bands*, or *false vocal cords*. They are also named the superior thyro-arytenoid ligaments.

Beneath these ventricular bands, and appearing to edge their free border, although in reality below them, are seen two white bands which pass forward from the anterior angles, or vocal processes, of the arytenoid cartilages to the receding angle of the thyroid cartilage. These are the *true vocal cords*. Between the free margins of the vocal cords is an open space of triangular shape with the base posterior, which varies in width as the cords approach or recede from each other. This is the glottis, or *rima glottidis*, and through this space can be seen the anterior surface of the trachea ridged by its rings perhaps down to the bifurcation into the bronchi. Between the arytenoids, at about the level of the vocal cords, is a point of considerable clinical importance, the space between the arytenoids, or *the interarytenoid space*.

A free space exists between the ventricular bands and the vocal cords. This space is found to follow the under surface of the ventricular bands, extending laterally and upward between the ventricular bands and the alæ of the thyroid cartilage on either side, and to terminate anteriorly in a blind pouch. The space is called the ventricle of the larynx, and the pouch named the sacculus laryngis (Fig. 542). This entire area is lined with mucous membrane richly supplied with mucous glands.

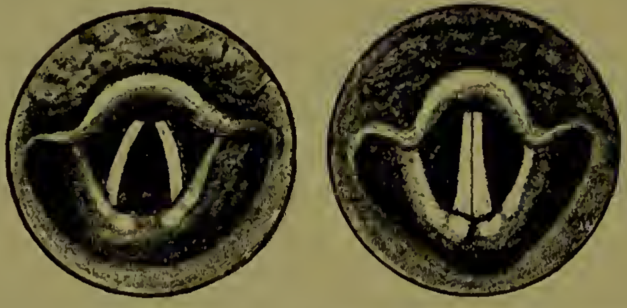

FIG. 541.—The laryngoscopic image in deep inspiration and in phonation.

The chink of the glottis varies in extent according to age and sex. In the adult male its length is about seven-eighths of an inch. In the female it is smaller. When fully dilated this triangular-shaped opening at its base posteriorly is about one-half of an inch in width. At the posterior attachment of the vocal cords will be seen usually a slight indentation of a whiter color than that of the main body of the cords. This point is the extremity of the vocal process of the arytenoids. It is of some clinical interest, as these points have at times been mistaken for ulcerations or cicatrices on this portion of the vocal cords.

The free margins of the vocal cords mark the most narrow portion of the larynx. Below these the subglottic space widens, assuming the general form of the circle formed by the cricoid cartilage, at first somewhat oval in the lateral diameter, soon changing to circular as the trachea is approached. Thus a section of the entire larynx would roughly resemble an hour-glass form, widening above and below, with a constriction in the center at the location of the vocal cords (see Fig. 548).

Muscles of the Larynx.—The muscles of the larynx are the posterior crico-arytenoids, the lateral crico-arytenoids, the interarytenoid or arytenoid, which act as the abducting and adducting muscles of the vocal cords; the thyro-arytenoids and crico-thyroid, whose function it is to regulate the tension of the vocal cords; the thyro-epiglottic, aryteno-epiglottic, superior and inferior, supplying some power of movement to the epiglottis; the thyro-hyoid and sterno-hyoid, which serve as muscles of fixation for the larynx.

The *posterior crico-arytenoid* arises from the posterior surface of the cricoid cartilage, on either side of the median line (Fig. 539). Its fibers pass upward and outward and are attached to the muscular process of the arytenoid cartilage (Fig. 540, 5). With point of fixation on the cricoid, this muscle, by contracting, rotates the arytenoid cartilage outward by drawing its muscular process backward. The two vocal processes of the arytenoid cartilages are thus drawn away from the median line outward, and the vocal cords are separated (see Fig. 665.

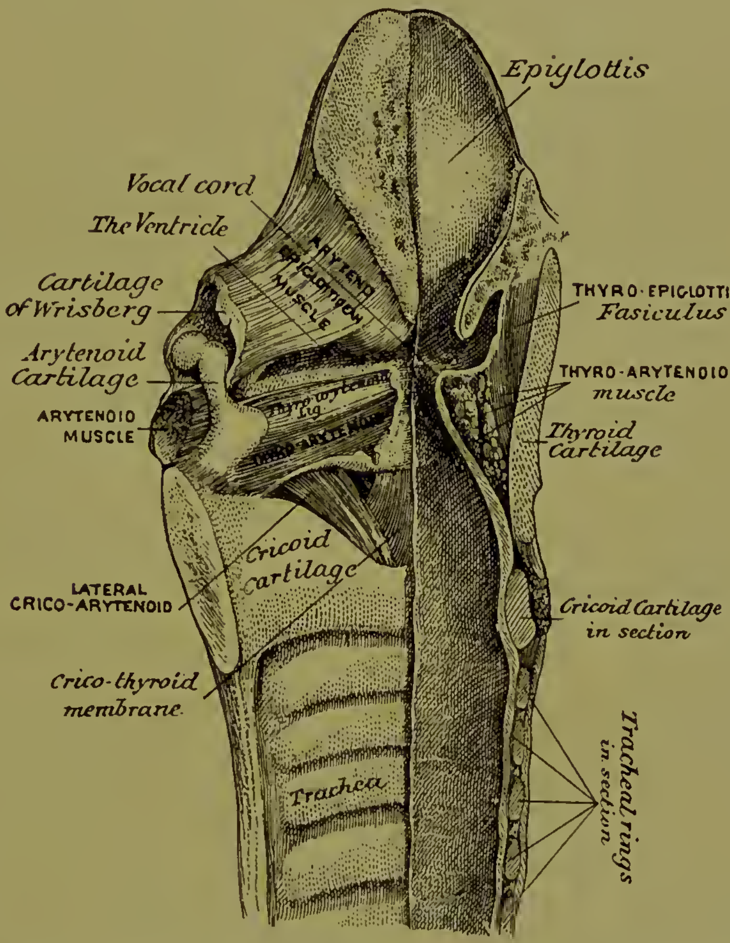

FIG. 542.—Interior of larynx, showing on the right the parts in median section, and on the left a dissection of this half, with the muscles and cartilages exposed (Allen).

The *lateral crico-arytenoid* muscles (see Fig. 540) arise, one on either side, from the upper margin of the lateral part of the cricoid cartilage. The fibers of each muscle pass upward and backward and are inserted in the muscular processes of the arytenoid cartilages at a point just anterior to the insertion of the posterior crico-arytenoid muscles. The action of the lateral crico-arytenoid muscles, being fixed at their cricoid attachments, is to adduct the vocal cords by drawing forward the muscular processes of the arytenoid cartilages, thus approximating the vocal processes of these cartilages (Fig. 665.

The *arytenoid muscle* is a single, square-shaped muscle with two sets of fibers, the transverse and oblique. The transverse fibers, which are the deeper, are attached to the posterior surface and outer margin of one arytenoid muscle and pass transversely across to be inserted into the corresponding part of the other arytenoid cartilage (see Fig. 540, 15). The more superficial oblique fibers consist of two thin muscular slips which pass from the base of one arytenoid cartilage to the apex of the other. In some instances fibers from the oblique bands pass around the outer sides of the two cartilages and blend with the fibers of the thyro-arytenoid or the aryteno-epiglottic muscles. The action of the arytenoid muscle is to bring the bases of the arytenoid cartilages together, thus completing the closure of the chink of the glottis. Contraction of the lateral crico-arytenoids alone leaves a small triangular opening between the cords at the interarytenoid space. This opening is closed by the contraction of the arytenoid muscle (Figs. 540 and 541). The *thyro-arytenoid* muscles lie parallel to and slightly below the vocal cords along either side of the larynx (Fig. 540). The muscles arise, one from either side of the receding angle of the thyroid cartilage, to the outer side of the insertions of the vocal cords. Passing outward and backward the fibers are inserted into the bases and anterior surfaces of the arytenoid cartilages and into the external surfaces of the vocal processes (see Fig. 542). Each thyro-arytenoid muscle is divided into two quite distinct portions, internal and external. The internal portion follows the vocal cord closely, some of its fibers, indeed, appearing to pass into the structure of the cord. The external portion passes backward along the outer side of the sacculus laryngis, and has a broad attachment to the external surface and outer side of the arytenoid cartilage. With point of fixation at the receding angle of the thyroid cartilage, the thyro-arytenoid muscles draw the arytenoid cartilages forward. The vocal cords are thus shortened and relaxed. The internal portion of this muscle, however, has an apparently contradictory action, for, by its attachment to the vocal cords, its contractions approximate the free margins of the cords and regulate their tension. This function is of importance in the production of the high notes in the singing voice. The external portion of the muscle, besides its action in shortening the cords, has also the power of compressing the sacculus laryngis. A superior thyro-arytenoid muscle is sometimes described (Santorini, Luschka, Schrötter), which is viewed by some authorities as a distinct muscle. Its origin is from the receding angle of the thyroid cartilage, immediately above the origin of the thyro-arytenoid muscle. It is attached to the muscular process of the arytenoid cartilage, some fibers passing downward to the cricoid cartilage or to the crico-thyroid membrane. It is quite probable that these muscular fibers, instead of forming a distinct muscle, constitute a series of oblique fibers which are, in reality, a part of the complex thyro-arytenoid muscle.

The *crico-thyroid muscle* arises from the anterior and lateral portions of the cricoid cartilages (see Fig. 540, 9). The fibers divide into two bundles, the more anterior pass directly upward and slightly backward and are inserted into the inner portion of the lower margin of the thyroid cartilage. The more posterior fibers pass upward and backward and are attached to the thyroid cartilage at the base of the inferior cornu. The action of this muscle is to render the vocal cords tense by increasing their length, either by drawing the thyroid cartilage downward toward the cricoid, thus stretching the vocal cords and increasing their tension, or, with the thyroid cartilage as the fixed point, to draw the cricoid cartilage upward and backward, which movement, it is claimed by the advocates of this method, will elongate and increase the tension of the vocal cords. The action of this muscle is a question which is still in dispute, and we feel that it has not yet been definitely decided.

Blood-supply of the Larynx.—The arterial supply of the larynx comes by the superior and inferior thyroid arteries.

The *superior thyroid* is a branch of the external carotid. It divides before entering the larynx into two branches, the superior laryngeal and the inferior laryngeal, the latter called also the crico-thyroid artery.

The *inferior thyroid artery,* one of the branches of the thyroid axis, supplies the muscles and mucous membrane of the posterior part of the larynx by means of its laryngeal branch, or posterior laryngeal artery.

Veins.—The laryngeal veins correspond in their courses to those of the arteries. They unite into three veins, the superior, middle, and inferior thyroid veins, which in turn enter the internal jugular vein.

Lymphatics.—The lymphatic vessels of the larynx collect from a thick network of vessels in the laryngeal mucous membrane into two trunks, one above the ventricle of the larynx and one below the cricoid cartilage. These trunks empty into the deep cervical lymphatic glands.

Nerves of the Larynx.—The larynx derives its nerve-supply from the pneumogastric nerve. The superior laryngeal branch of this nerve is the general nerve of sensation for the mucous membrane of the larynx, and is the motor nerve for the crico-thyroid muscle and for the arytenoid muscle, the latter being supplied also by the recurrent laryngeal nerve.

The recurrent laryngeal nerve is the general motor nerve of the larynx.

The *superior laryngeal nerve* arises in the inferior ganglion of the pneumogastric. It passes downward along the sides of the pharynx to the superior margin of the thyroid cartilage. Here it divides into an external and an internal branch. The external branch of the superior laryngeal nerve passes downward beneath the sterno-cleido-mastoid muscle to supply the crico-thyroid muscle. The internal branch pierces the thyro-hyoid membrane and supplies all the mucous membrane of the interior of the larynx, as well as the base of the tongue, with sensory filaments. It sends filaments to the arytenoid muscle, and anastomoses with the recurrent laryngeal nerve.

The *recurrent laryngeal nerve,* sometimes named the inferior laryngeal nerve, is also a branch of the pneumogastric. On the right side of the body this nerve leaves the pneumogastric at about the level and in front of the right subclavian artery. Passing around this artery from before backward it ascends to the side of the trachea, posterior to the common carotid and inferior thyroid arteries. In winding about the subclavian artery the recurrent laryngeal nerve on the right side comes in very near relation to the apex of the right lung.

On the left side of the body the recurrent laryngeal nerve leaves the pneumogastric in front of the arch of the aorta. It passes around the aortic arch from before backward at the side of the ductus arteriosus, and passes upward to the side of the trachea. Both right and left recurrent laryngeal nerves pass upward in the groove between the trachea and esophagus. They pass beneath the lower border of the inferior constrictor muscles of the pharynx, gaining entrance to the larynx just posterior to the articulation between the inferior cornua of the thyroid cartilage and the cricoid cartilage.

They supply all the muscles of the larynx with motor filaments, with the exception of the crico-thyroid muscle. There is anastomosis between the recurrent laryngeal and superior laryngeal nerves.

The relations of the recurrent laryngeal nerve—on the right side with the apex of the lung and with the subclavian artery; on the left side with the arch of the aorta—are of great clinical importance, as paralyses of the laryngeal muscles may result from pressure against the recurrent laryngeal nerve by aneurysm of the vessels named, at the point of passage of the nerve around them, or, on the right side, by irritation from the inflammatory conditions in the apex of the right lung. The motor fibers of the recurrent laryngeal nerve are supposed to be derived from the spinal accessory nerve. Russell of London [1] has investigated the nerve-supply of the abducting and adducting muscles of the larynx and feels warranted in "the conclusion that the muscles closing and opening the glottis are respectively supplied by different bundles of nerve-fibers, preserving an independent course from center to periphery, the abductors being situated on the tracheal side and the adductors on the external side of the nerve." This theory still requires more general observation, as does also that of Onodi, quoted by Bosworth, that the laryngeal muscles receive a supply of motor fibers from the spinal cord, by way of the spinal ganglia of the sympathetic system, extending as low as the lower cervical and first dorsal spinal ganglia, the course of the fibers being direct from the spinal cord to the first thoracic ganglion; then through the communicating branch between this ganglion and the last cervical ganglion; and from this latter directly to the recurrent laryngeal nerve. The advantage of having a double motor nerve-supply for the muscles of the larynx is quite obvious.

The Mucous Membrane of the Larynx.—The laryngeal mucous membrane is continuous with the lining membrane of the pharynx and trachea. Its epithelial covering is generally of the squamous variety. Over the lower or posterior surface of the epiglottis it is columnar and ciliated. This is also true of the mucous membrane extending below the ventricular bands, which is continuous with and corresponds to that of the trachea. The vocal cords, however, are covered with squamous epithelium. The mucous membrane is rather loosely attached to the submucosa over the anterior surface of the epiglottis, on the posterior surface of the arytenoids, on the aryteno-epiglottic folds, and in the ventricle of the larynx. This fact accounts for the rapid development of edema of these parts in very severe inflammatory processes.

The larynx contains an abundant amount of lymphoid tissue, especially at the border of the epiglottis and in the aryteno-epiglottic folds, the arytenoids, the interarytenoid space, and the ventricles of the larynx.

The Trachea.—The trachea extends from the lower margin of the cricoid cartilage to the bronchial tubes, a distance in the adult of about four and one-half inches. It is a cylindrical tube flattened posteriorly where it lies in contact with the esophagus. It is a membranous tube partially surrounded by incomplete rings of cartilage. It extends from the fifth cervical to the third dorsal vertebra, where it divides into the two bronchi. Its transverse diameter varies from three-fourths of an inch to an inch. Internally it is lined with mucous membrane covered with columnar ciliated epithelium and richly supplied with lymphoid tissue and mucous glands.

The trachea is surrounded and partly covered by important structures. The common carotid and inferior thyroid arteries lie on either side of it, together with the recurrent laryngeal nerve. Crossing it on a level with the second and third tracheal rings lies the isthmus of the thyroid gland in a sheath formed by two layers of the deep cervical fascia. The lobes of the thyroid gland lie on either side of the trachea and larynx from the isthmus to the thyroid cartilage. Below the isthmus and immediately over the trachea is a network of veins, the intrathyroid plexus.

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[1] *Brit. Med. Journ.*, June 18, 1892; *Annual of the Univ. Med. Sciences*, vol. xiv. F. 3, 1893.

On either side of the trachea, in the superficial fascia of the neck, lie the two anterior jugular veins, at about two-fifths of an inch from the median line. These veins communicate by a transverse trunk which crosses in front of the trachea immediately above the sternum. Of the arteries, the crico-thyroid must be recalled crossing the crico-thyroid membrane. An anomalous vessel, the *arteria thyroidea ima*, is fonnd in rather rare instances running up the front of the trachea from the arch of the aorta. The innominate artery, crossing the trachea at the level of the episternal notch, sometimes crosses higher up within the field of a low operation for tracheotomy. In very rare instances both common carotids spring from the innominate artery. In such cases the left common carotid crosses in front of the trachea to reach the left side of the neck. In all operations for tracheotomy the relation of the trachea to these important structures lying about it, and this possible anomalies, must be borne in mind.

THE CLINICAL ANATOMY OF THE NASAL CHAMBERS.[1]

By Harrison Allen, M. D.

Correct impressions of the localities in which morbid processes occur in the nasal chambers, as well as the means resorted to for their relief, demand, to a degree perhaps greater than in other parts of the economy, an intimate acquaintance with the structure and relations of the component parts.

The peripheral olfactory apparatus must be conceived as a special membrane covering the nasal aspects of the lateral masses (Figs. 543, 545), these uniting with the cribriform plate and the perpendicular plate to form the ethmoid bone. Each lateral mass is comparable to the eyeball or to the petrous portion of the temporal bone, in the meaning of the term that it is devised to protect an organ of special sense. The conditions under which the act of smelling is efficient demand the act of breathing to be also efficient: hence, each lateral mass is a part of a system of bones which is in free communication with the outer air. The bones are named as follows: the vomer, the ethmoid bone, the sphenoid bone, the nasal bones, the superior maxillæ, the palatal, the inferior turbinated, and the lacrymal bones.

The ethmoid bone, the vomer, and the sphenoid bone belong to the brain case, since they are developed with those structures which enter into the composition of the base of the skull. The nasal bones and the incisorial intermaxillary portions of the superior maxillæ are developed in pairs from the fronto-nasal process of the embryo. The remaining parts also arise in pairs, but at the sides of the skull, and (excepting the lacrymal) extend inward to join the median structures. All of these, with the exception of the ethmoid and inferior turbinated bones, have relations distinct from those pertaining to the nasal chamber. The communication of the nasal chamber with the ethmoid cells, the frontal, the maxillary, and the sphenoid sinuses add greatly to the intricacy of the region. The os planum is often perforated at more than one point in advanced disease of the ethmoid cells, as is the floor of the orbit in disease of the maxillary sinuses. While both of these systems are accessory to the nasal chambers (Fig. 548), their clinical relations therewith are important.

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[1] Through the untimely death of the author, this section failed to receive his final revision and personal choice of illustrations [Ed.].

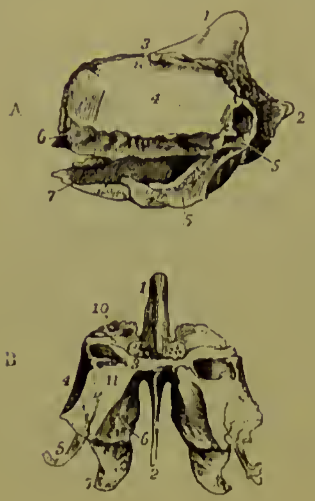

FIG. 513.—Back and side view of the ethmoid bone, showing in B the lateral masses on either side of the vertical septal plate (2), with which they are united by the cribriform plate (3) at the base of the crista (1). Between the nasal meatus and the orbital plate (4) are the cells, the closure of many completed by the frontal and other bones articulating with the ethmoid and projecting downward are the superior (6) and middle (7) turbinates and the uncinate process (5) (Allen).

The nasal chamber is conveniently divided into three parts by planes, the initial lines of which are started at the transverse sutures of the floor.

The anterior part lies in front of the maxillo-premaxillary suture: the vertical transverse section defining it will answer to the interior (vestibule) of the external nose (nearly).

The middle part lies between the maxillo-premaxillary suture and the maxillo-palatal suture: the plane defining it, beginning in front at the *ductus ad nasum*, will embrace the lateral mass of the ethmoid bone (nearly).

The third part lies back of the maxillo-palatal suture and includes the vertical plate of the palatal bone with the end of the middle turbinal: the plane defining it is sharply limited by the anterior border of the vertical plate of the palatal bone. The third part is continuous with the internal pterygoid plate in the meso-pterygoid fossa.

It may be observed that the inferior turbinated bone has no morphological value and is ignored in the definitions of the planes.

The variations in the nasal chamber are numerous, and it is not assumed here that the regions above named are uniform. They are available, however, since they are based on function and are true in the great majority of examples of crania. Among the exceptions to some statements may be mentioned the following: the floor of the nose in advance of the maxillo-premaxillary suture is sometimes so shortened as to yield a plane which would not contain all or nearly all the interior of the external nose. The middle turbinated bone sometimes projects forward beyond the line of the *ductus ad nasum* into the anterior third.

The anterior third is in reality a canal of entrance to the olfactory surfaces, and the posterior third is in a less exact sense a canal-like passage of exit. The part last named is the same at different periods of life and in all animals; while that of the anterior passage is exceedingly variable, both in ages of the individual and in groups of animals.

Each nasal chamber is bounded by the roof, the floor, the outer, and the inner, or septal, walls.

The Roof.—The roof of the nasal chamber is confined to the undersurfaces of the nasal bones in advance of the frontal, a small, unimportant, and variable surface of the bone last named; the cribriform plate of the ethmoid bone; and, at the extreme posterior part, a portion of the body of the sphenoid bone. The cribriform plate is an exceedingly vulnerable part of the roof. Many examples are on record of wounds penetrating it; and its position at the top of the cleft, between the septum and the middle turbinated bone, as the parts are seen when inspected by the anterior rhinoscopy, must be borne in mind in all intranasal procedures.

The Floor.—The floor of the nasal chamber on either side of the incisor crest is elevated in proportion as the crest itself is developed (Fig. 546); when the crest is absent, or of moderate proportion, the floor of the vestibule is on the same level as that of the horizontal plate of the maxilla. On the whole, it is disposed to incline downward slightly from before backward. An abrupt fall or "break" in the inclination is sometimes demonstrated at the point where the incisorial portion of the floor ends and the maxillary portion begins (Fig. 546). It is of importance to detect the change of level, for secretions may accumulate in the angle and by undergoing decomposition resist

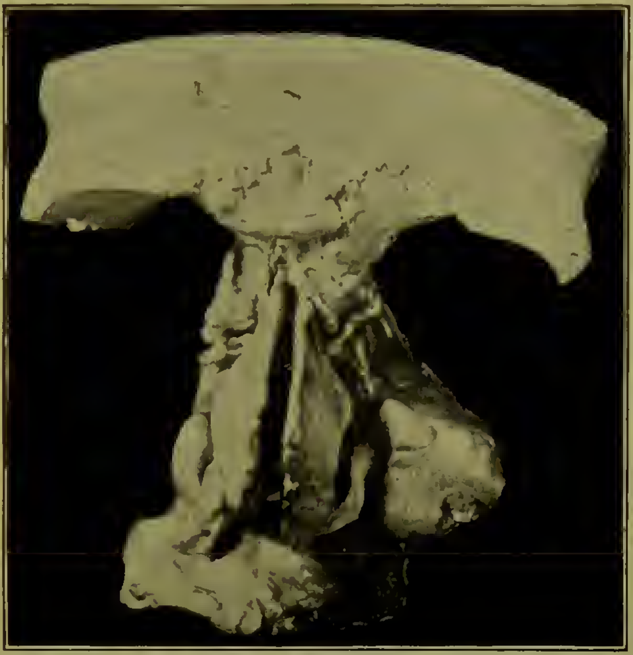

Fig. 544.—Metal cast of the upper air-passages and oral cavity, showing the maxillary sinus on the right, asymmetrical frontal sinuses above, with the delicate infundibulum and the anterior ethmoid cells. (Randall).

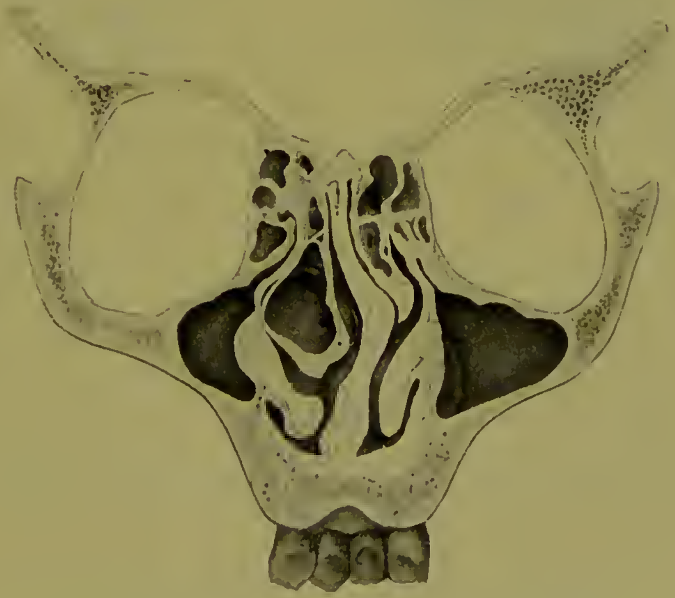

Fig. 545.—Transverse section of the nasal chambers, showing marked asymmetry, the bulbous left middle turbinated bone apparently deflecting the septum to the right and narrowing the maxillary sinus (from Zuckerkandl).

efforts to correct the causes of fetor. The mucous membrane in the recess may be ulcerated and the lesion escape observation. Straight plugs, tubes, or cannulæ cannot be carried conveniently to the floor of the passage at a level below that of the incisorial portion.

The Outer Wall.—The outer wall of the nasal chamber embraces the superior, middle, and inferior turbinated bones and the uncinate process. On the lateral mass of the ethmoid bone is defined the superior meatus; between the middle and the inferior turbinated bone is the middle meatus; and between the inferior turbinated bone and the floor of the nose the inferior meatus.

The Middle Turbinated Bone.—The middle turbinated bone, while understood to be but a process of the ethmoid bone, is clinically defined as though it were a separate element. It presents many variations, and their study becomes a matter of the first importance. The bone, as seen foreshortened in the living subject, relates less to the outer wall of the nose than is described in the manuals of anatomy. It might be compared to a stalactite hanging near the roof of an irregular cavern. It may be laminar, without increased width of the free lower border, which is variously deflected; it may have a moderate amount of inflation and appear in sections pyriform in outline, thus constituting perhaps the average condition; or, as is often found in females, it may be enormously inflated so as to exhibit in sections a veritable globose contour (Fig. 545). Infrequently the inflation is not confined to the pendant portion, but extends into the anterior portion of the pedicle as well, where it may even involve the adjoining ascending process of the maxilla.

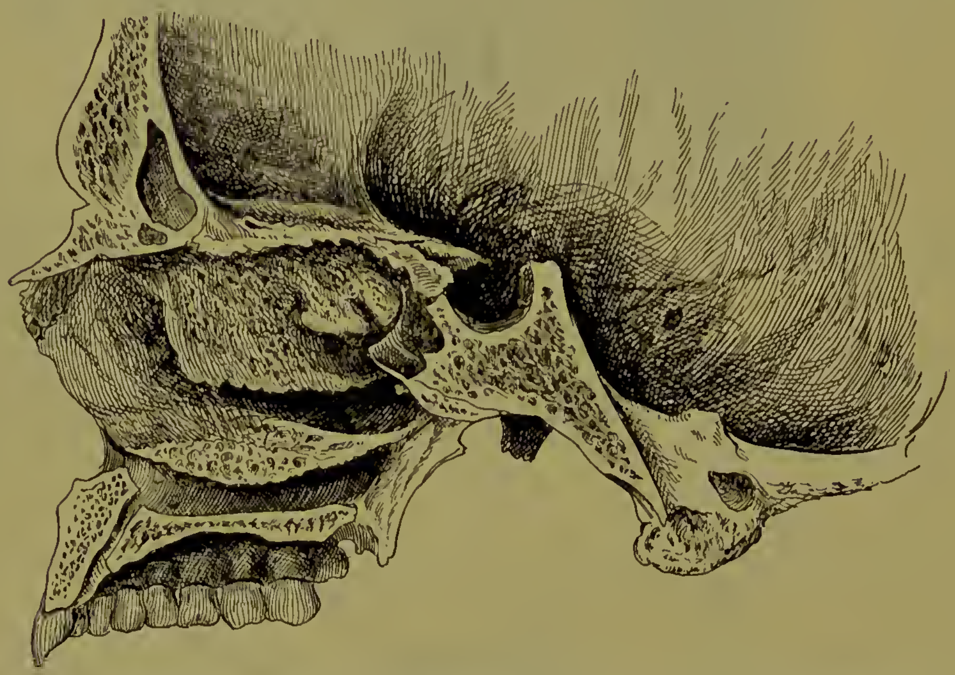

FIG. 546.—Sagittal section of the skull, showing the bony outer wall of the nasal chambers, with the turbinated bones and the rise of the floor in front at the incisorial foramen.

The size of the middle turbinate varies, quite apart from its shape. As a rule, the bone answers to the lower limit of the perpendicular plate of the ethmoid bone where it joins the vomer; while it rarely extends below this line, it often falls short of it. One of the most interesting variations in the ethmoid bone arises from the arrest of development after an attack of scarlet fever. The lateral mass remains stunted and is lodged high up in the chamber. When ostitis persists, as is often the case, the proximity of these masses to the cribriform plate should lead the practitioner to conduct all local treatment with due care. It is quite true that small ethmoid bones are sometimes examples of arrest of development from fundamental causes, and probably in some degree correlated with defects in the normal rate of evolution of the brain. For we must not overlook the harmony known to exist between the size of the olfactory surfaces, at least of the ethmoid bone, and the functions they subserve in extending the distribution of the special nerves over a peripheral organ.

The middle turbinate is composed of a straight or globose anterior part and a deeply concave posterior part, the concavity being directed outward. The concave part (conch) can be explored from in front and subjected to treatment, for it is often the seat of retained secretion and granulation-tissue. The median and anterior surfaces of the bone are less coarsely marked than is the inferior turbinate, although it may be provided anteriorly with numbers of small spicules. In the infant the anterior end is always thin, compressed, and parallel to the perpendicular plate, although the free lower end is deflected either inward or outward, more commonly in the direction first named. In all ages the bone inclines downward and backward to a degree greater than is seen in the inferior turbinate (see Fig. 546).

The Inferior Turbinated Bone.—The inferior turbinated bone is attached to the maxilla and palate-bone so as to form a bond of union between these structures. It extends the length of the nasal chamber—the extreme front border just back of the anterior nasal aperture being in some examples free. The bone is marked by numerous coarse depressions, grooves, and rugosities. It is concave on its outer surface and convex or straight on its inner. Seen in the living subject the anterior end presents a rounded, almost cherry-shaped mass, often with scarcely a suggestion of the position of the inferior meatus, although this region can be carefully outlined by the aid of the probe; the inner (median) surface of this part of the inferior turbinated bone is, as a rule, sharply convex and, indeed, is the most rounded of any part of the surface. Not infrequently it or its covering forms in diseased states septal apposition, if not actually false union or synechia. In my opinion the disturbing factor in the formation of this union is not septal but turbinal, and the reduction of the turbinal is of greater use than the disturbance of the septum. Directly back of the point of septal apposition the convexity of the bone in great part disappears. The inferior turbinate is often of considerable height—a variation never seen in like degree in cabinet crania. In cleft palate the free inferior border tends to grow down to a deeper plane than is normal.

The Middle Meatus and the Uncinate Process.—Above the middle turbinated bone lies the middle meatus, sharply defined both from in front and behind. The most conspicuous structure seen in the skull in this region is the uncinate process of the ethmoid bone. Usually this process lies parallel to the anterior part of the lateral mass, but it often projects at right angles to the plane of these cells, from which in the living subject it is often difficult to separate it. The process may be mistaken for the middle turbinate. In text-books the usual account of the process is to state that it narrows the opening from the maxillary sinus into the middle meatus. This it certainly does; but its more important clinical connection is to the cells with which indeed it is in true morphological relation. In some instances the process is deeply concave on its anterior surface, and its median border is turned sharply forward. When the lateral masses are moderately developed the process makes no impression upon the eye in the living subject, and is imperfectly discerned even in the skull; but when the process is at right angles to the outer wall the anterior ethmoid cells (Fig. 547) are always large, and as a rule, constitute a single, rounded, cherry-like mass (bulla ethmoidalis). Thus, when the right-angled position of the process is detected, the observer may conclude that the enlarged cells lie directly behind it. It is the relation existing between the uncinate process and the anterior ethmoidal cells and the ascending process of the maxilla that makes this part of the nasal chamber of importance in studying the relations existing between lacrymal and nasal disease. Directly within the middle meatus is sometimes seen the opening into the maxillary sinus, and within the inferior meatus that of the lachrymal canal.

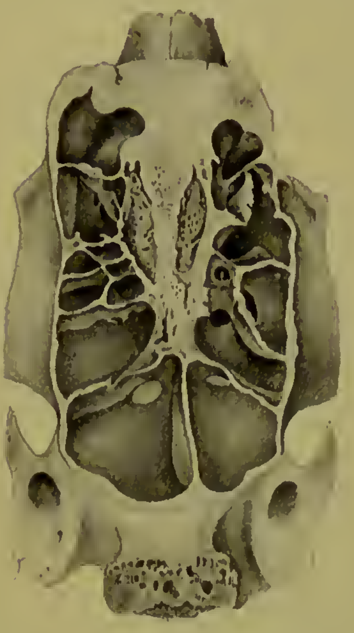

FIG. 547.—Horizontal section passing above the cribriform plates and showing the ethmoid, sphenoid, and frontal sinuses with their openings toward the nares (Zuckerkandl).

The Inner, or Septal Wall.—The word "septum" implies that the two chambers are being studied together and that the septum is a partition. In this essay the septum is assumed in the main to yield the inner wall of each chamber (Fig. 544). The septum is composed of a bony and a cartilaginous part. The anterior third (about) of the bony septum is notched; the upper border of the notch is defined by the perpendicular plate of the ethmoid bone, the lower border of the vomer and incisor crest of the maxilla. The notch is occupied by the triangular cartilage, which appears to be unfortunately named—according to the studies of Freeman, it is of a quadrilateral figure. The bony inner wall of the nasal chamber is composed of the perpendicular plate of the ethmoid bone, the vomer in front of its alæ, the incisor crest, the anterior nasal spine, and that much of the horizontal plate of the superior maxilla which ascends to form a crest. The incisor crest, the spine, and the process last named differ from the perpendicular plate and the vomer in being composed of symmetrical parts, and, in common with all such structures, present variations according to the manner in which the right and left constituents unite. This statement is particularly applicable to the incisor crest and the nasal spine, which present innumerable variations—no two specimens being alike. The nasal spine is developed before the crest, and is not simply the anterior end of this elevation, as is usually stated. The crest is always rudimental in young subjects, and, indeed, is often absent, although the spine may be prominent. Although divided into right and left parts in adults, not infrequently the crest remains in its juvenile condition throughout life. As a rule, it is well developed and has a disposition not to extend backward beyond the incisive foramen. The vomer, passing forward as a single straight plate deeply grooved for the accommodation of the triangular cartilage, will have its relation to the crest undisturbed so long as the structure last named is of moderate development; but if it be more than usually high the union is not harmonious. Hence arises the thickening of the septum at this place and the disposition to deflection either to the right or left—in most cases the latter. The height of the incisor crest is often so great as to cause the septum to be unyielding in the region answering to the height of the inferior turbinated bone. If a high crest is also carried well to the outer wall of the nose it creates an exceedingly narrow passage within the vestibule.

The perpendicular plate of the ethmoid bone may project forward beyond the maxillæ and downward so far as greatly to narrow the size of the septal notch. It may constitute, when malplaced, an important factor in nasal obstruction. The prognosis should always be guarded when the plate is so disposed.

Sharply defined projections from the septum are called "spurs." As a rule, they are ledges of varying degrees of development. The most common of the "spurs" is on the upper vomerine border, either where it forms the lower boundary of the triangular notch, or where it is joined by the perpendicular plate of the ethmoid bone. But a spur is often found high up and back on the septum, and may occupy in great part the middle meatus.

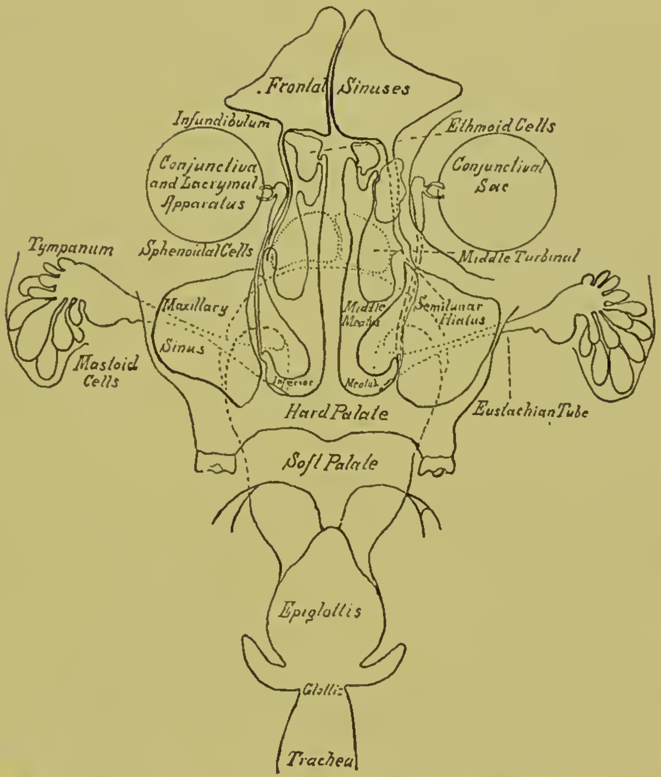

FIG. 548.—Scheme of upper air-passages based upon metal corrosion casts.

Asymmetry of the nasal chambers is generally acquired and is often the result of injury. Errors in growth and development may arise, however, in the nasal chambers as elsewhere in the economy. Asymmetries of the group last named are in great measure products of civilization. Ethnological cabinets furnish material for study less valuable than that obtained from the dissecting room or observed in our patients. Inflammatory or other obstructive conditions, even when temporary in character, may cause narrowing of the passages. Whatever may be the etiology of these confessedly obscure variations, the fact remains that one chamber, commonly the left, is the smaller, and that the septum inclines away more or less from the median line. A summary of the above statement is here given: Deviation of the septum from a straight line is associated with a high incisor crest; and when this is well established, the vomer tending to grow forward when there is no space in front to permit it so to do, it is deflected from the straight line; or if it enters into the compass of the triangular notch, it is itself abruptly turned to the left.

Far back in the nasal chamber, at a place answering to the union between the perpendicular plate of the ethmoid and the vomer, an irregular ridge can often be felt in making digital examinations. The ridge is more common on the left than on the right side, and is of varying degrees of hardness. Often it can be pressed away by the finger; but more commonly it will not yield unless sawed or drilled.

The degree of consistence of the septum and turbinated bones is subject to variation. The former may be thin and porous or thick and eburnated. No sign is accepted by which the state of the bone can be determined by inspection. Large bones projecting well into the chambers may yield to slight interference, while small bones may be exceedingly resistant. The application of these facts to practice are of importance. A thin, yielding septum may be the cause of failure in attempting to arrest hemorrhage by plugging the chambers. A marked deviation can sometimes be corrected by the finger to almost the degree desired; while if the parts be thick and firm nothing will yield until they are attacked vigorously by the aid of instruments.

The Nasal Apertures.—The apertures of each nasal chamber are two in number, the anterior and the posterior. The anterior is the nostril and the posterior is the choana. The nasal chamber is examined by reflected light thrown through the nostril, or by a mirror carried into the naso-pharynx, which reflects the view as seen at the choanæ. When the skull is examined, the anterior nasal aperture takes the place of both the nostrils; and the mid-region of the base of the skull, of the naso-pharynx. If it is accepted that the nostril is an aperture, the term cannot be used as a synonym for "nasal chamber," as is sometimes done by clinical writers. The term "naris" is discarded.

The *anterior nasal aperture* is defined by the maxilla and the nasal bones, and is exceedingly variable when a series of all races of men is examined. But in clinical studies—excluding those conducted on the negro—the opening is pyriform, with the base of the figure downward, and presents two trenchant asymmetrical borders which are raised above the level of the floor of the nose. The entire figure has been compared to the heart on the playing card. Welcker happily likens it to the figure of the European elm (*Ulmus montanus*), from the fact that the lower border of one of the chambers (commonly the left) is below the level of the other. The conjoined incisor crests of the maxillæ often appear at the aperture. The perpendicular plate of the ethmoid bone, infrequently here seen, may even project beyond its plane, thus in reality converting the anterior nasal aperture into two apertures.

The *choana*, or *posterior nasal aperture*, is bounded inferiorly by the posterior margin of the palatal bone. The lateral margin answers to the anterior border of the internal pterygoid plate. It would be difficult to define the upper margin were it not for the presence of a group of minute bone-spicules which receive no name in anatomy, so far as I am aware, which, nevertheless, are exceedingly useful in defining the plane of each choana. The inner margin is the septum, but this is not a reliable guide to the base of the choana, since the posterior margin of the vomer often lies well forward on the crest between the palate-bones. I have called this phase of the nasal septum "recedent," to distinguish it from that form where the base comes sharply up to the base of the posterior nasal spine. In subjects that exhibit the recedent form, the vomer will allow the posterior ends of the inferior turbinals to approach, although they do not touch—the mucous membrane over both bones remaining normal. Care should be taken in such conditions not to confound these masses with hypertrophy of the posterior ends of the turbinal bodies.

The region of the choanæ, after all is said, is not of importance. In

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practice the choanæ in reality include the *meso-pterygoid fossa*, or, as I have ventured to call it, the *posterula*, or back porch to the nasal chamber. This is a single region into which the choanæ debouch. It contains the alæ of the vomer and all of the inner surface of the internal pterygoid plates. The finger introduced into the naso-pharynx is received into the posterula, and the pterygoid surfaces are clearly defined at the sides. In rare instances these may be thickened, retaining the infantile form, and may aid other conditions in tending to reduce beyond normal limits the posterior apertures of the chambers.

The Nasal Mucous Membrane and its Blood-vessels.—The mucous membrane lining the nasal chambers is of three kinds: first, the olfactory membrane, which is limited (nearly) to the ethmoid bone on the inner aspect of each lateral mass and the opposed surfaces of the perpendicular plate; second, the highly vascular and partially erectile structures (turbinal bodies) covering the inferior turbinated bones; third, the generalized membranes which line the other bones and the walls of the accessory sinuses.

The property of cocain in constricting small blood-vessels is used with advantage in studying the anatomy of the nasal chambers in the living subject. The contrast in the shapes of the inferior turbinal body before and after an application of a 10 per cent. solution of cocain is such as to give the observer an accurate impression of the extent of the erectile mucous membrane covering it. The cushion surfaces of the bodies with contour convex before the cocain is applied disappear, and in their places are noted a membrane bound down to the bone, to whose irregularity it conforms. We speak of a turbinated bone and a turbinal body—the latter phrase to express the fact that the body is an erectile membrane which has a shape in a measure distinct from the skeletal surfaces with which it is closely incorporated.

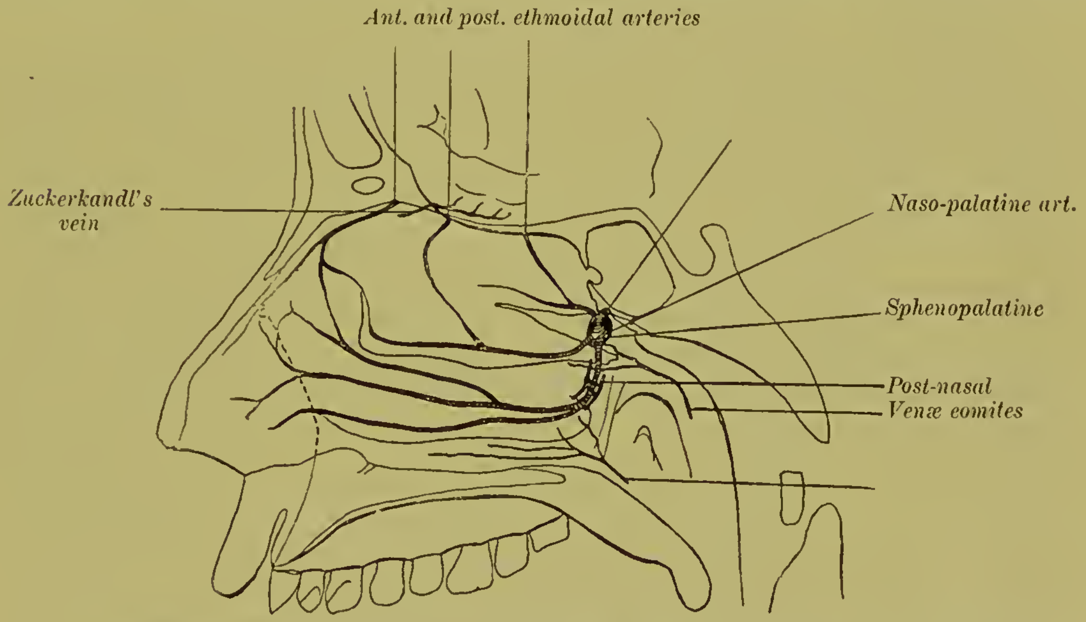

FIG. 549.—Vessels of the lateral wall of the nose, showing direct cerebral communication through Zuckerkandl's vein (Zarniko).

As a rule, incisions into the turbinal body are followed by moderate bleeding, which ceases spontaneously. Occasionally wounds over the middle turbinal bleed more freely, which in order to stanch require interference by pressure or use of astringents. The mucous membrane on the outer wall and in the sinuses is uniformly indisposed to bleed so as to demand interference. It is far different with the septum. Here the cartilaginous portion, where it joins the incisor crest, is exceptionally vascular. A caruncular swelling is often found at this point, which should be carefully avoided in making incisions for minor surgical procedures. A second point from which hemorrhage is apt to occur is over the triangular cartilage itself. This is never from an incision, but is commonly from abrasions, and is therefore the region from which blood often springs in non-surgical epistaxis. The seat of hemorrhage is found at a point just beyond the tip of the triangular notch. Hemorrhage occurring from wounds reaching the submucous tissues is far different from the foregoing. Two distinct locations are here noted—namely, the septum along the line of the vomer at any part, which answers to the positions of the deep septal blood-vessels; and the posterior third of the outer wall, where it receives the arteries and veins which pass through the spheno-palatine foramen (Fig. 549).

The bones of the nasal chamber are remarkable for being in whole or in part covered with mucous membrane, and are supplied largely with its blood-vessels. The muco-periosteum is a valuable term in describing such a membrane, for it fixes the mind upon the analogy between such a membrane and the periosteum. If the comparison between the two membranes is precise, then the study of the nasal chambers as part of the great skeletal group of bones, being as exact in pathology as in anatomy, relegates many of the morbid conditions of the chamber to phases of periosteitis and osteitis.

The Nerves.—The nerves that must be recalled in surgical treatment of the nasal chamber are unimportant. The operations on the nasal septum will sometimes cause numbness of the incisor and canine teeth to be complained of for a few days after operation.

Asymmetry and Narrowing of the Nasal Chambers.—It has been stated on page 831 that the nasal chambers are often asymmetrical—the asymmetry being caused by deviation of the nasal septum, usually to the left side, and that such deviation is acquired either as a direct result of traumatism or of disease. The chambers, however, may be unequal in size, even when the septum remains straight. Such a relation is due to fundamental causes, and will be found, like all these conditions, to correlate with other peculiarities in the economy. An important element in prognosis is here to be considered, for a congenitally narrowed or occluded chamber can never be made entirely efficient. Sometimes the posterior portion only of the chamber exhibits asymmetry. This is due to a defect in the development of the sphenoid bone, the body of which does not normally expand; thus the pterygoid processes are kept too close together, the palatal bones, as well, remain in an infantile condition, and in time the choanæ are even inadequate for the accommodation of the posterior ends of the turbinals. If an operation be proposed for deviation of the septum or other causes of obstruction in the anterior portion of a chamber of a subject where the posterior portion remains undeveloped, a statement of the results to be expected should be guarded, since the narrowing at the choanæ and postcrula may in itself maintain obstruction. In these cases the choanæ are always small and oval; the internal pterygoid processes are convex, and the turbinals are thick and pressed together against the septum. Cases have been observed characterized by retention of all these parts in an embryonic condition, with resultant atresia. Even when the choanal plane is normal, narrowing may occur at the posterior third of the chamber; thus converting each posterior portion into a passage, which might be compared to a funnel laid on its side and with its neck directed forward.

PHYSIOLOGY OF THE UPPER AIR-PASSAGES.

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The study of the physiology of the nose, throat, and larynx is of the greatest practical importance, for it is only by an intimate knowledge of their functions in health that we are able correctly to appreciate the significance of pathological conditions. At times, indeed, when insurmountable difficulties prevent thorough physical examination, we must fall back upon our knowledge of the normal functions of the parts, such as breathing, swallowing, phonation, etc., to obtain a correct diagnosis.

NOSE.

The old idea of the nose as simply an organ of olfaction has given place to an appreciation of the influence it exerts upon the whole economy, not only by its vital functions of warming, moistening, and filtering the inspired air, but also by its acting as a protective organ to prevent the admission of harmful substances in inhalation.

Functions of the Nose.—*Respiration.*—(1) Passage-way for air in breathing; (2) warming, moistening, and filtering the inspired air.

Olfaction.—(1) Perception of odors in inspiration; (2) perception of flavors in expiration.

Phonation.—(1) Resonance; (2) production of overtones.

Protection.—(1) By sensation; (2) by olfaction.

Ventilation.—(1) Of the ears; (2) of the accessory sinuses.

Respiration.—(1) We notice from the dryness of the throat in mouth-breathing that this is not the passage-way intended by nature for the air in inspiration, and we realize that normal respiration should take place through the nose, and that mouth-breathing is a pathological condition giving rise to many injurious results.

Paulsen has proved that the air in respiration takes a very different course from that formerly supposed to be the case.

Instead of flowing back along the inferior meatus, the air passes directly upward from the nostril to the superior meatus, whence it falls by a gentle curve toward the choana.[1] This shows the old arbitrary division of the nose into a lower respiratory and an upper olfactory portion to be, physiologically at least, incorrect. It seems curious that the inferior meatus should thus be avoided by the inspiratory currents, for the inferior turbinals contain the largest amount of vascular tissue. It must be remembered, however, that nowhere in the nose is the air at rest, and as the air in the inferior meatus is more sluggish, it has received more heat, and when drawn into the current

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[1] One can readily be convinced that the stated course of the air is the true one by examining the nose of a person who has inhaled finely divided magnesium. The powder will be found adhering to the anterior end of the middle turbinal and as far up the olfactory cleft as one can see, while the inferior meatus and turbinal remain almost entirely free (Fig. 551). Hence the common appearance of dust and crusts on the anterior ends of the middle turbinals.

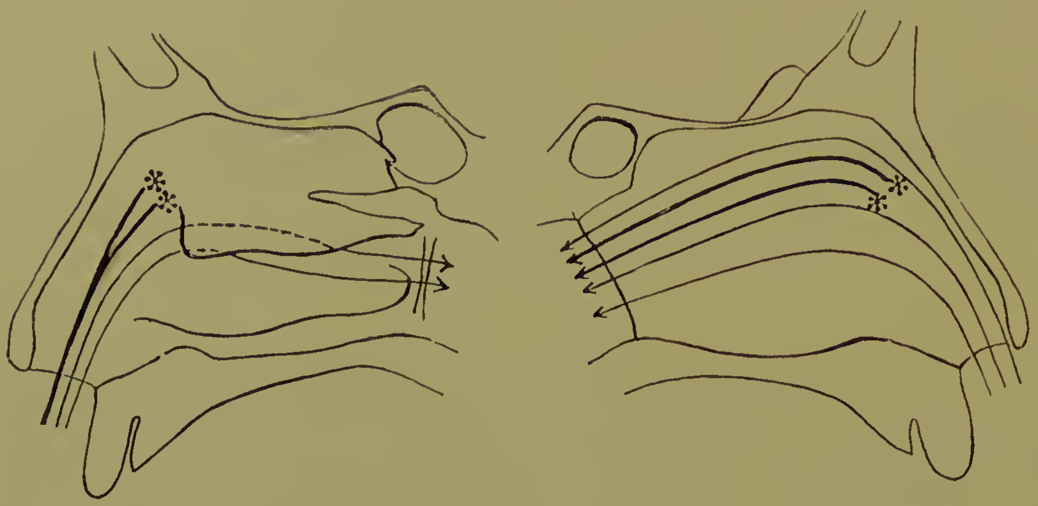

FIG. 550.—Diagram showing the course of principal and auxiliary currents of air in normal respiration.[1]

raises its temperature more quickly.[2] The main currents of air pass into the naso-pharynx at the highest portion of the choanal arches, and an enlargement of the pharyngeal tonsil, encroaching even slightly upon these openings, impedes respiration much more than does swelling of the ends of the inferior turbinals, blocking to a marked degree the lower portion of the choanæ (compare Fig. 560).

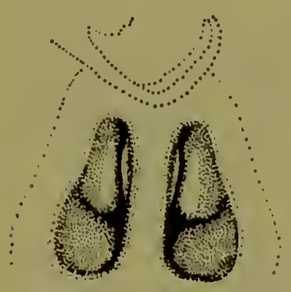

FIG. 551.—Anterior nares, showing white deposit of inspired magnesium-powder upon the septum and middle turbinals only.

The course of the air in expiration is nearly the same as in inspiration, except that it is directed higher up—*i. e.*, through the posterior part of the superior meatus, a point that we shall soon see is of importance in detecting flavors.

(2) Within the nose the shelf-like arrangement of the turbinated bones gives increased extent of surface to the vascular membrane with which they are covered. The interior of the nose is completely lined with mucous membrane, that covering the inferior turbinals, the lower portion of the middle, and the posterior ends of the middle and superior turbinals, containing vast systems of blood-vessels, which are the chief source of the heat and moisture supplied to the air in inspiration. These blood-sinuses are surrounded by involuntary muscular fibers, and, although they are commonly so called, they are not, correctly speaking, true erectile bodies, which consist of large irregular spaces lined with pavement epithelium. This muscular tissue is under the control of the sympathetic system, which reaches the interior of the nose by way of the spheno-palatine ganglion, and derives its influence from the cerebro-spinal system. It is known that there are vaso-dilators as well as vaso-constrictors, and their centers probably lie in the floor of the fourth ventricle.[3] The dilatation and contraction of the sinuses caused by these nerves are constantly going on, and are physiological actions of great importance. The object is the regulation of the amount of blood in the turbinals, and hence the proper warming and moistening of the inspired air. The mechanism is, indeed, a delicate one which is able to supply the requisite amount of heat

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[1] Zarniko: *Die Krankheiten der Nase*, etc., p. 38. Later observers have not only confirmed this, but have found that the air takes a still higher course.

[2] Zarniko, p. 40.

[3] Chapman: *Human Physiology*, p. 732.

and moisture under all the varying changes of temperature and humidity to which animal life is subjected. Thus we notice that when the temperature is cold, the turbinals swell and the passages become more closed. This indicates that the vascular tissue has become filled, and that a large amount of warm blood is being brought into contact with the impeded current of inspired air, raising its temperature to a higher degree. While the swelling of the turbinals is frequently accompanied by increased secretion, this is not necessarily the case, for we may have the one independent of the other. Were it otherwise, in cold weather we should normally have excessive secretion, a condition, however, which, although frequently met with, is due to abnormal sensitiveness of the nasal mucous membrane to contact with cold air. We know that at 32° F. air, to be saturated, requires but 2.1 gr. of water to the cubic foot. Thus the tissues of the nose would be called upon for very little moisture in cold weather did they not, in raising the temperature of the inspired air, also raise its saturation point, which goes to illustrate the nice balance which must normally exist. According to Aschenbrandt and Kayser, the inspired air receives from 20° to 40° of heat,[1] and becomes saturated, or nearly so,[2] in its passage through the nose. This renders it suitable for the interchange of oxygen and carbonic acid gas in the lungs, a simple action of osmosis which takes place most perfectly when with warm fluid on one side of a membrane there is warm, moist air on the other.

To supply the large amount of water necessary to moisten the inspired air, Bosworth has calculated that about a pint should be secreted by the nose, and this is obtained from the sinus-tissue of the turbinals, together with the tears and the secretion of the muciparous glands.

The function of the nose in filtering the inspired air is practically perfect, for Tyndall has demonstrated that the expired air is free from germs. This takes place, first by action of the vibrissæ, the hairs of the vestibules, which hinder the entrance of large particles, and next by the adherence of smaller particles to the moist surfaces of the intricate passages of the nose and naso-pharynx. When in large amount, or when the nose is too roomy, or pathological conditions interfere with this normal filtering process, particles may reach the lower respiratory tract. While the mucus is an important agent in arresting the dust, the ciliæ are in no less degree active in cleansing the surfaces. The ciliary wave in the nose is toward the naso-pharynx, that in the naso-pharynx toward the mouth, while that in the lower respiratory tract is upward, so that foreign particles are carried toward the mouth and thus removed, either by expectoration, or, more physiologically, by swallowing. The activity of the ciliæ depends very much upon the quality of the mucus with which the membranes are covered; for in certain states, when there is much viscidity, it is known that their action is much hindered. This gives rise to a feeling of stuffiness, so great at times that patients with fossæ so open that one is able to see the vault through both sides, complain that the nose is obstructed. We see, therefore, the vital functions exercised by the intranasal mucous membrane; and a correct knowledge of its physiological functions should teach us as far as possible to avoid cauterization or destruction of this tissue, and to remove instead septal overgrowths or to correct deformities of the septum which interfere with respiration.

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[1] To determine the amount of heat thus imparted to the inspired air, Bloch has formulated the following rule: The amount of heat is equal to five-ninths the difference between the body-temperature and that of the external air. Taking, for example, the temperature of the air at 32° F. and that of the body at 98.5° F., we have five-ninths of 98.5° – 32°, or about 37°. Consequently the temperature has been raised from 32° to nearly 69° F. in its short passage through the nose.

[2] Bloch is probably correct in the experiment showing that the inspired air is only two-thirds saturated, for we notice an uncomfortable feeling in breathing completely saturated air.

Olfaction.—(1) As a function for yielding pleasure and for serving as a means of information and protection, olfaction has been held in far too low estimation. In man this sense receives very little attention, partly because of the protected position which the organ of smell occupies, thus greatly diminishing its liability to injury, and the consequent infrequency of disorders of olfaction, but more especially because of the almost universal lack of development and training. It is probable that in the course of evolution, devolution of this sense has taken place, and that in primitive man it was much more highly developed. Indeed, in certain cases we find the sense so acute that its possibilities seem almost incredible.[1] The increase in size and number of the turbinals would seem to have an important bearing on the sense of olfaction, as furnishing greater extent of surface for distribution of olfactory nerves. While the presence of a fourth or even a fifth turbinal is probably due to a persistence of the sagittal furrows found in the embryo, the fact that a fourth turbinal is present in certain negro tribes in whom olfaction is very acute seems to point toward the lessening of the function in civilized man as due to lack of development of the organ of olfaction.[2] Not only has there been an apparent degeneration of the sense, but directly bearing upon this, also a decrease in size of the olfactory lobes and the fields of distribution of the nerves.[3] Thus while most writers claim that the terminal filaments are distributed to the middle as well as the superior turbinal and the region of the septum opposite, Schultze's investigations, confirmed by von Brunn's careful measurements, have proved that the olfactory epithelium does not reach the lower edge of the *superior* turbinal by $7\frac{1}{2}$ mm., and that the whole olfactory surface, divided nearly equally between the turbinal and the septum, has an extent of but 257 sq. mm., although this is increased slightly by scattered islands of olfactory cells. The olfactory organ, then, is placed in the remotest region of the nose; and it is, therefore, only by an appreciation of the direction of the air-currents in respiration that we are able to understand how it can be acted upon at all by odoriferous particles.

In order that we may detect odors, certain conditions are essential. The perceptive structures must be normal, nasal respiration must be unhindered, and the surface must be moist.[4] The external nose and the power of sniffing[5] are also necessary in order that the current of air may be properly directed into the superior meatus. Then again, that the odor of substances may be perceived, they must be either in a gaseous state or in a state of fine subdivision and capable of absorption. Whether the odoriferous substances cause olfaction by their specific weight, by their power to absorb heat (Tyndall) by their chemical properties, or by their specific action on the pigment cells[1] of the olfactory region, can probably never be stated definitely. It is a matter of speculation and theorizing at present, and many ideas as to its mode of action have been advanced. It seems probable that the theory that olfaction depends upon the chemical composition (Haycraft) and molecular weight of the substance will finally be generally accepted.

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[1] The sense of smell is far more acute in the lower races of man than in the higher, to whatever extent in the latter it may have been developed. Thus Arabs are said to smell fire thirty miles away (Chapman, p. 764).

[2] Fisher and Penzold have found that in man $\frac{1}{230000000}$ mg. of sulphur-alcohol (over ten times more powerful than musk) to one liter of air was the utmost limit in which odor could be detected. The ability, however, with which animals are able to follow a trail shows that their sense of olfaction is much more acute than that of man (Gaule: *Heymann's Handbuch der Laryngologie und Rhinologie*, vol. iii. p. 196).

[3] The olfactory bulbs and nerves are best developed in animals in which the sense of smell is most acute. The olfactory region is most developed in the dog (Chapman, p. 764).

[4] Whether moisture is necessary because it protects the epithelium, or whether it has a more specific action in transmitting the sensation, we do not know; but olfaction is markedly hindered if membranes are dry, although not interfered with even if secretion is excessive.

[5] Anosmia may be due to facial paralysis, the power of sniffing being lost. It may also be caused by loss of the external nose, being restored when the nose is replaced by operation.

(2) The greater part of the sensation that we designate as taste is, in reality, olfaction[2]—that is, olfaction during expiration. The term taste should, strictly speaking, be limited to perception of sweet, sour, bitter, and salt, the only sensations detected by the nerves of gustation ; but so narrow an interpretation cannot be adhered to as yet. One can readily be convinced of the truth of this statement by holding the nose while drinking or eating, for thus the currents of air are unable to pass through the nose, and all flavors and odors are unperceived. Also in cases of imperforate choanæ, although the organs of olfaction are normal and the nasal fossæ otherwise free, the senses of smell and taste are both in abeyance because of the absence of both inspiratory and expiratory currents through the nose. It is in the experience of everyone that severe coryza will likewise rob a person not only of smell, but in a great part also of taste. The great delicacy of the sense of taste seems to be due to the course of the air in expiration, as it passes higher in the nose and thus more powerfully affects the olfactory region.

Phonation.—(1) Resonance being an increase in the volume of sound, the voice gains its strength and character by the reverberation of the air contained in the nasal passages and accessory sinuses. The hard palate must be looked upon as a sounding-board and as a decided factor in transmitting the vibrations to the chambers above. We can, then, understand the reason why growths that obstruct the nasal cavities destroy the character of the voice, not only by preventing the passage of air through the nostrils, but by interfering with vibration. While the accessory sinuses have been variously stated to be intended to lighten the skull, to act as sources of warm air and as reservoirs for mucus to moisten the nose, and for use in olfaction, these functions are of little or no weight in comparison with the important part they play as resonating chambers. Even the frontal sinuses seem to have influence in this direction ; for the native Australian negroes, who have no frontal cavities, have voices singularly lacking in resonance, a peculiarity said to be due to this malformation. The explanation of the musical voice of the African negro, so contrasted with the unsympathetic tones of the American Indian, seems to lie in the greater size of the antra in the former race.

(2) The nose and naso-pharynx are also necessary, as Helmholtz has shown, for the production of overtones, which give character and increased richness and volume to the voice.

Protection.—(1) We have already spoken of the protection afforded by the nose in removing from the inspired air foreign particles which would otherwise penetrate to the delicate pulmonary alveola. But the nose serves also by its sensitiveness to touch to prevent injurious substances from gaining admittance, or by calling forth reflex action, such as sneezing, to cause their expulsion. For these purposes we have an abundant supply of both sympathetic and sensory nerves distributed to the interior of the nose. The trigeminus is the great sensitive nerve of the nose, and transmits the impressions received through both its ophthalmic and superior maxillary branches. Thus the entrance of irritating substances first gives rise to a cessation of breathing, followed by a forcible expiration to remove the offending material. This is usually accompanied by a free flow of mucus due to the irritation of the trigeminus and sympathetic, the former exciting an abundance of clear, non-viscid secretion, and the latter a scanty, but very viscid, flow.

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[1] Darwin states that animals with darker pigment in this region have more acute sense of smell. The dark-complexioned races are also known to have the olfactory sense more highly developed. Hutchinson reports the case of a negro who turned white and subsequently lost the sense of smell. Ogle reports that white herbivorous animals are more apt to be poisoned by eating poisonous plants than those with darker pigment (Bosworth).

[2] Ogle reports two persons both of whom by a blow on the head lost the sense of olfaction, yet the true sense of taste was preserved. No difference could be detected by them between boiled onions and apples or port and Burgundy wines ; of the wines, the first seemed like sweetened water and the other like dilute vinegar (Zwaardemaker : *Die Physiologie des Geruches*, p. 9).

(2) The importance of olfaction in protecting the organism against injurious air and food is seldom appreciated, although its function in enabling certain animals, such as the carnivora, to track their prey and procure food, and others, such as the deer or rabbit, ill-protected by nature for self-preservation, to avoid danger, is universally recognized.

Ventilation.—(1) The part played by the nose in the function of ventilating the middle ears can best be understood by observing the interference which takes place when nasal respiration is obstructed. We know from the Toynbee experiment—that of swallowing while the nostrils are closed—that the air within the tympani is rarefied and the membranes become retracted. Grave consequences frequently arise from the persistence of the malposition of the tympanic membranes thus taking place in cases of hypertrophied turbinals, deformities of the nasal septum, etc., which obstruct the free passage of the air through the nose, and therefore interfere with ventilation through the Eustachian tubes.

(2) A somewhat similar action takes place in the accessory sinuses, although the effects cannot be directly observed and do not usually give rise to such serious results. According to the experiment of Braune and Clausen, while the pressure in the nose in breathing is equal to from 7 to 10 mm. of water, in the act of *sniffing* the vacuum formed in the superior maxillary sinus is equal to a negative pressure of 780 mm. of water. This explains Randall's observation, that by sniffing one may readily produce hemorrhage from the lining membrane of these cavities, especially when they are acutely congested.

NASO-PHARYNX.

The naso-pharynx possesses no special sense, but the location here of the pharyngeal tonsil and numerous muciparous glands, whose functions are those of protecting and lubricating the throat, makes it of great importance. It serves also as a resonating chamber of great value for the voice, and contains muscles by whose action the tympanic cavities are ventilated.

While the pharyngeal tonsil *per se* is too often considered an abnormal growth, and its function as a germinating center for leukocytes is overlooked, its enlargement interferes so markedly with the vital processes of free nasal breathing and normal ventilation of the ears that its physiological functions should not weigh against such important considerations when damage is threatened by its presence. It has been said that the function of the pharyngeal tonsil as a source of lubricating secretion for the pharynx is of no importance, judging from the atrophic processes which affect it in adult life. Granting that this pathological condition is widespread, so that the most familiar picture is that of absence or of great reduction in size, it is nevertheless my experience that only those throats can be looked upon as normal in which all the tonsils, although small, are present and in good condition. So, also, in the nose, the sclerotic condition of the turbinals in late adult life, termed senile atrophy, is looked upon as the natural accompaniment of age because of the frequency of its occurrence, in apparent forgetfulness of normal though rare cases, where the turbinals are as large and smooth as in youth.

Sensation in the naso-pharynx is supplied not only by the trigeminus and glosso-pharyngeal nerves, but also by the superior laryngeal. From this fact arise many erroneous impressions in patients, who refer to the region of the larynx sensations arising in the naso-pharynx.[1]

The ventilation of the ears is brought about by the action of the palatal muscles. While the velum hangs relaxed, the openings of the Eustachian tubes are nearly vertical slits; but in the act of swallowing they open and become somewhat triangular in shape, allowing the free entrance of air. During "empty" swallowing this is even more pronounced, for the soft palate then ascends to its utmost limits, and in this manner the regular physiological ventilation is constantly provided for.

MOUTH.

Among the many functions of the mouth, want of space will permit only a brief reference to certain ones bearing directly upon our subject. Besides those concerned in deglutition, the mouth has a most important influence on articulation, the consonants and many of the vowels being formed by the movement of the lips and tongue. It also acts as a speaking-trumpet to throw the concentrated and amplified sounds in definite directions. By means of the special sense supplied by the glosso-pharyngeal and lingual nerves we are able to distinguish only the sensations of salt, sour, bitter, and sweet. These impressions are conveyed to the centers of taste in the brain through the fibers of the chorda tympani from the anterior two-thirds of the tongue, and through the glosso-pharyngeal nerves from the posterior third.

While the nerves of special sense of the nose and mouth contribute much to our pleasure in eating and stimulate the powers of salivary secretion and digestion, our enjoyment is due also to the consistency and other characteristics of the food which act upon the nerves of general sensibility. The glosso-pharyngeal and lingual are also nerves of general sensation, and like the trigeminus in the nose act as guards against injurious substances. The intensity of the sensation of taste depends upon the "solubility and concentration of the substance and upon the degree of force with which it is rubbed in, as in tasting."

THROAT.

Limiting the term throat to the oro-pharynx, we find its physiology of much importance, for here are located anatomical structures connected with the nose, mouth, and larynx, making their functions interdependent, so that the physiology of the pharynx is really that of the related parts.

Among the many physiological functions which find their expression here are the voluntary ones of articulation and sucking. Deglutition and retching are for the most part involuntary and occur reflexly. The pharynx has important influence in articulation, especially in modulation of the voice, as in singing. In sucking, the base of the tongue is drawn downward and outward, and thus creates a vacuum, breathing in the meanwhile being carried on through the nose, between the acts of sucking and swallowing. The vital importance of maintaining free nasal respiration during infancy should be too well recognized to need further comment.

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[1] One must be on his guard against following implicitly the assertions of the patient as to the seat of sensation. Many a foreign body in the tonsil has been sought for in vain in the larynx through following blindly the patient's opinion of its supposed location.

While deglutition is at the beginning a voluntary act, when once started it becomes involuntary. It is brought about reflexly by stimulation of the nerves of the pharynx, which happens normally by the presence of food, etc., or pathologically by any sensation of foreign substance in the throat. Thus, among other things, any abnormal dryness of the pharyngeal mucous membrane, or enlargement of the lingual tonsil, or thickened secretion hanging in the throat may give rise to the ineffectual or "empty" swallowing which so often causes great distress. In swallowing normally, the action begins at the tip of the tongue, which is pressed against the roof of the mouth, the other sections following in order, the substance to be swallowed being thus forced backward into the pharynx. The anterior pillars of the fauces then come together, and, with the arched tongue, shut off the return to the mouth. Then the superior constrictors contract, forming an elevation (Passavant's cushion) across the posterior pharyngeal wall, which, meeting the elevated soft palate, shuts off the entrance to the naso-pharynx. In paralysis of the velum, as after diphtheria, or in destruction or cleavage of the soft palate, the closure is incomplete, so that fluids and even solids regurgitate into the vault and even through the nose. In hypertrophy of the pharyngeal tonsil, which hinders the full elevation of the velum, and in adhesion between the tonsils and the anterior pillars, which prevents the soft palate from ascending, the same insufficiency occurs. Following the contraction of the superior constrictors, the middle and inferior constrictors[1] of the pharynx act involuntarily and reflexly and force the object downward. At the moment of swallowing, the larynx is drawn upward and forward under the tongue, and the epiglottis is thus usually[2] forced over the laryngeal opening.

In retching, which precedes vomiting, there is contraction of the lateral walls of the pharynx so that they may meet in the median line. The center for vomiting[3] being near that of respiration in the medulla, practical use may be made of this knowledge in preventing vomiting during examination of the throat. By noticing this premonitory contraction of the fauces and directing the patient to breathe deeply and quickly, the tendency to retching may very frequently be stopped and the examination completed.

TONSILS.

While the physiology of these structures will be treated more fully in the section allotted to them, it seems desirable to emphasize here the important part they play as protective organs. It is now recognized that all the lymphatic tissue, whether in the form of simple collections of lymphatic cells scattered throughout the nose, Eustachian tubes or pharynx, or collected into prominent groups, as in the naso-pharynx, fauces, or at the base of the tongue, are germinating centers for leukocytes. That absorption is a special function of the tonsils, as asserted by some, is probably a mistake; for although made up of lymphatic tissue, they are not in direct connection with the general lymphatic system. Their peculiarly irregular surface favors the catching and retention of substances, and absorption can of course take place as easily here as through any mucous membrane.

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[1] Meltzer has experimentally shown that the middle and inferior constrictors are not absolutely necessary even for the deglutition of solids (Einthoven: Heymann, vol. ii. p. 58).

[2] It has been shown that the epiglottis does not even normally always close the opening of the larynx (Schmidt: *Die Krankheiten der oberen Luftwege*, p. 45).

[3] It is not necessary to have any irritation of the fauces to bring about the action of retching, as there are fibers connecting the vomiting-center with the convolutions. The simple thought, by translation, may act upon the center, and, as we often see, may cause gagging merely at the sight of the examining instrument (Landois: *Physiologie des Menschen*, p. 295).

SOFT PALATE AND UVULA.

We have spoken of the elevation of the soft palate in deglutition. As its elevation prevents the escape of food into the naso-pharynx in swallowing, so its elevation prevents, and its relaxation permits, the passage of waves of sound through the nose, and thus its action is of great importance in speaking. Particularly is this action of importance in singing, for the naso-pharynx and nose are especially concerned in the production of overtones, which give fulness and character to the voice.

Too little attention has been given to the physiological functions of the uvula. While it is generally recognized that it assists in more securely stopping the entrance to the naso-pharynx when the soft palate is elevated, I regard its most important function as that of acting on the edge of the velum like a weight on a drop-curtain. In all the shades of tone the uvula is of great influence in causing the edge of the velum to fall more quickly, overcoming the tendency for its moist surface to adhere to that of the posterior pharyngeal wall. The rapidity of the actions of the soft palate in singing or speaking can scarcely be appreciated until one has observed its movement directly, as in patients after the removal of the superior maxilla. That this function exists and is of practical importance can be readily recognized from the change in voice produced by too long or too heavy an uvula.

LARYNX.

The two important physiological functions of the larynx are those of protection of the delicate structures below and of voice-formation. In addition, it has the function of regulating the amount of air in breathing, which is done reflexly, the glottis widening with each inspiration.

Of these, by far the most important to the whole economy is the function of protection. The contact of anything irritating with the sensitive structures guarding the larynx immediately causes them to contract, thus preventing its entrance; or, if it has gained admission, the sudden escape of air through the glottis tends to carry with it the offending substance, and the action is accompanied by a harsh sound (cough), due to the rough vibrations of the vocal cords. It is not only solid particles which thus call into action the protective function of the larynx, but also certain gases, such as ammonia and chlorin, called irrespirable gases; and even strong wind, whether warm or cold, act in a somewhat similar manner.

The larynx produces sound by throwing the column of expiratory and inspiratory air into vibration as it passes over the approximated edges of the vocal cords. This would give rise to sound of very limited nature, but it is so modified by the force of the current (volume), by the size of the opening (pitch), and by the influence of the surrounding cavities (quality), that the voice may become the most perfect of musical instruments. The action of the larynx is not like that of a pipe in the production of tone, for in order to give the low note, Do (64 vibrations), it would have to be some 8 feet long; neither is its action like that of a stringed instrument, for it would necessitate a cord many feet in length to produce this low note.[1] Its action closely resembles that of the hautboy, in which the sound is produced by a combination of pipe with a vibrating reed. The knowledge of this fact is made use of after laryngectomy by employing a reed in the artificial larynx to enable the patient to talk.

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[1] Chapman, p. 846.

GENERAL ETIOLOGY AND PATHOLOGY OF DISEASES OF THE UPPER RESPIRATORY TRACT.

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Diseases of the upper respiratory tract—that term for the purpose of this article being confined to the naso-pharyngo-laryngeal region—may be either local conditions or local manifestations of some general disease, and they are as varied as are the tissues which go to make up these complex organs. Thus we may have any known pathological condition of the mucous membrane, cartilages, bones, blood-vessels, or glandular tissue.

In an article devoted to the consideration of the general etiology, pathology, and symptomatology of diseases of the upper respiratory tract, it will be possible to give only a general idea of some of the more common conditions met with in this region.

Of all the tissues composing this tract, the mucous membrane is the one most frequently affected, and it is subject to three forms of inflammation, viz., the catarrhal, the croupous, and the diphtheritic.

Catarrhal inflammations affect adults as well as children, and they are the most common affections we have to deal with. They have been recognized from the earliest times; early writings showing the familiarity of the ancients with these affections and their influence on the general health. These inflammations have become more frequent and have increased in severity during the present century, owing to the complex conditions of modern civilization, which has no doubt developed new influences which operate to produce these severe conditions.

They have a widespread distribution over the earth's surface, and are more frequently met with in cold than in warm climates, and in high than in low latitudes. In the temperate zone, according to Seitz,[1] they are most frequently observed between the isotherms of 18° and 4°; although there is no region absolutely exempt. In a study of the etiology of these affections it is desirable to know the superficial contour as well as the geological character of the region before the full influence of the humidity and the temperature and barometric changes can be estimated. Changeable temperature has a great influence in the production of these affections; therefore they are more prevalent in the spring, when the temperature and winds are more variable, than in the fall.

The **causes** of catarrhal inflammations are both exciting and predisposing. Among the exciting causes may be mentioned a sudden exposure to cold when the body is scantily clad, thus giving rise to the phenomenon of "catching cold." There are several theories as to the process of catching cold. The theory of Rosenthal is that the cold acting upon the surface of the body excites the arterioles to contraction, by which the blood is driven from the surface to the internal organs including the mucous membranes, and there acts as an irritant, exciting an inflammation. This theory is based upon the faulty assumption that a part is inflamed because it receives more blood, whereas it really receives more blood because it is inflamed.

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[1] *Catarrh and Influenza*, 1865, p. 85.

The theory of Seitz is that inflammations resulting from catching cold are the result of removing heat to an undue extent from the external surface of the body, this sudden removal causing some functional disturbance of the body by which a morbid process is set up. Neither of these theories explain satisfactorily the phenomena that take place. Bosworth[1] is more nearly correct when he states that the action of cold upon the body is probably upon those nutritive changes which are constantly going on within the body, and by which animal heat is produced. Any interference with this heat production results in a morbid process which, in a mucous membrane, shows itself in the form of an inflammation.

A much more potent factor in the production of catarrhal inflammations than simple exposure to a low temperature is the degree of the relative humidity of the atmosphere. Probably the most frequent cause of this form of inflammation to-day is the influenza, an infectious disease which appears in epidemic form, rapidly spreading from place to place. It is of microbic origin, and bacteriologists have succeeded in isolating the specific germ which causes it. The local conditions of this affection differ in no wise from a simple catarrhal inflammation, except in the degree of the inflammatory process.

Aside from the effects of the changes of temperature, the inhalation of irritating vapors and finely divided mechanical irritants is an important factor in the production of these conditions. Such irritants are particularly noticeable in our large manufacturing cities, where the atmosphere is heavily laden with smoke and gases produced by the large factories, as well as with particles of dust which come from the pulverizing of asphalt in our modern pavements. These substances being constantly inhaled produce more or less irritation, which eventually results in a low form of inflammation. A more limited number of cases arise from some systemic or organic influence or from some functional disturbance; and a few cases may depend upon some structural defects in the parts themselves. Prominent among the predisposing causes from within the organism are gastro-intestinal disturbances arising from errors in diet or over-indulgence of the appetite. It is a matter of common occurrence that a defective digestive process and imperfect assimilation exert their harmful effects in the production of reflected irritation in the upper air-passages. This frequency is noticed in children under the third and fourth year, in whom attacks of indigestion so readily occur, and who show a great degree of reflex sensitiveness. Aside from the so-called reflex disturbances, the gastro-intestinal disorders are frequently the direct source of inflammation of the upper respiratory tract. Chronic pharyngitis, one of the most universally distributed diseases of this region, has probably for its most common origin disturbances of the stomach. Dr. T. R. French,[2] who has recently made a very interesting contribution to the study of this subject, states that in all cases of chronic pharyngitis there is some disorder of the stomach. In conjunction with Dr. C. S. Fisher he examined the throats of 23 patients whose stomach-contents had been examined after a test-meal, and in all of these patients there was found some form of stomach disorder associated with a pharyngeal catarrh. It is not only the pharynx and naso-pharynx, but also the nose and larynx that may be affected by such conditions. Ariza, cited by Moreau Brown,[1] mentions three forms of laryngeal disturbances that result from gastric affections :

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[1] *Diseases of the Nose and Naso-pharynx*, p. 58.

[2] *N. Y. Med. Journ.*, Sept. 12, 1896.

(1) Laryngeal hyperesthesia, where the patients complain of a burning sensation and pain in the larynx, but where the fauces and larynx are perfectly normal.

(2) A condition in which the vocal cords and surrounding parts are both hyperemic and painful, varying in intensity according to the severity of the gastric disorder.

(3) A reflex paralysis dependent upon gastro-intestinal disturbance.

Then there are apt to be acute attacks frequently occurring in the neurasthenic, and accompanied by more than ordinarily profuse serous discharge.

Aside from the dyscrasia, such as syphilitic and tubercular diatheses, which render the mucous membrane peculiarly liable to take on inflammatory action, there are other constitutional affections which play a very important rôle in the production of diseases of the upper respiratory tract, such as gout and rheumatism. There are certain conditions of the throat in which the pain is out of all proportion to the amount of local disturbance observed ; and it is in such cases that gout or rheumatism will in the majority of instances be found to be the exciting cause. While my own experience leads me to believe that the association of certain forms of tonsillitis and rheumatism is something more than accidental, I consider the question to be still unsettled. If the researches of Henry L. Wagner[2] and others who claim to have found the same microbe in tonsillitis and in the blood in rheumatism are confirmed, it will go a long way in clearing up this much-mooted relationship of tonsillitis to rheumatism. There are certain forms of rhinitis, especially the hyperesthetic variety, either associated with asthma or not, which are frequently observed in overfed and plethoric subjects, and which have for their causation a surcharging of the system with uric acid.

Prominent among the causes of catarrhal inflammations of the pharynx, larynx, and trachea may be mentioned the pernicious habit of mouth-breathing resulting from some morbid condition within the nose, or to hypertrophy of the lymphoid tissue in the vault of the naso-pharynx. The cold, unfiltered, and unmoistened air passing over the pharynx into the larynx and trachea affords a great disposition to catarrhal inflammations of these organs.

The strong influence of many modes and habits of life in the production of these affections is obvious, among which may be mentioned a sedentary life in a close vitiated atmosphere, and the custom of overheating the houses so frequently observed in this country, thereby rendering the subject sensitive to the changes in the weather.

Numerous micro-organisms find an excellent culture-soil in the oro-pharyngeal tract, some of which are harmless, while others are pathogenic in character and are the source of the infectious and contagious affections, such as diphtheria, scarlet fever, whooping-cough, and phlegmonous inflammations that are met with in this region. Lennox Browne[3] further subdivides these micro-organisms into a third group, which are innocuous so long as the subject enjoys perfect health, but so soon as this is depressed or there is any abrasion of the mucous membrane systemic infection takes place, with sometimes serious results. In this later group may be classed the leptothrix buccalis, the pneumococcus, and the diplococcus, all of which are frequently

[1] *N. Y. Med. Journ.*, Aug. 29, 1896.

[2] *Trans. Amer. Laryn. Assoc.*, 1894.

[3] *Diseases of the Throat*, 3d Ed., p. 161.

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found in the healthy mouth and throat. To these may be added the staphylococcus albus and aureus and the streptococcus pyogenes.

The nose, on the other hand, does not offer such a fertile soil for the growth of these micro-organisms as does the oro-pharynx, for according to the researches of St. Clair Thomson[1] and Hewlett, who have recently investigated this subject, it may be stated that the occurrence of micro-organisms on the Schneiderian membrane is so infrequent that their presence must be regarded as quite exceptional. This is borne out by our clinical experience, for infectious diseases of the nose are much less frequent than in any other part of the upper respiratory tract. Paget[2] has confirmed the above results, and finds the nasal cavities in the normal state free from microbes except at the anterior part and vestibule. He concludes that the asepsis of the nasal cavities is due to the structure of the canal, to the ciliated epithelium, and to the germicidal quality of the mucus, which he finds is absolute for the anthrax bacillus, very marked for the Klebs-Löffler bacillus, and less so for the staphylococcus and streptococcus organisms. This explains why operations in this region show a certain degree of immunity from infection.

Pathology.—While the pathology of ordinary catarrhal inflammations is comparatively simple, there are certain conditions which are much more difficult to understand. Among them may be mentioned hypertrophy of the lymphoid tissue in the vault of the pharynx, hypertrophy of the turbinal bodies, and deformities of the septum, resulting either from ecchondroses, exostoses, or deflections. In order to comprehend fully the pathology of inflammations of the upper respiratory tract, it is necessary to understand the pathology of inflammations in general. They may be said to result either from the action of micro-organisms, or from an irritant of which cold is the most common example. The impression produced by cold upon the vaso-constrictor nerves stimulates them to contract the capillaries of the skin, the result of which is a diminution of the blood-supply to the periphery and a reflex to the internal organs including the mucous membranes. If these organs are in a state of health no harm will result. In those cases, however, where there is a deviation from the normal and the internal resistance is not sufficient to maintain the equilibrium, the capillaries dilate at the weakest point from overpressure. This is the condition of hyperemia or the first stage of inflammation. If now the cause is removed and the paralyzing effect on the vessels overcome, the hyperemia may subside and recovery occur. If, however, the cause should continue to operate, or the paralyzing effect on the blood-vessels cannot be overcome, the case passes on to the second and third stages of inflammation. The increased rapidity of the circulation, which is the first effect of the dilatation, is soon followed by a slowing of the blood-current; the leucocytes begin to seek the periphery of the stream, which adds to its stagnation; while the pressure from behind continuing, a transudation of the fluid constituents of the blood through the walls of the vessels takes place, and is thrown out on the surface of the membrane. This exudate varies in quality, according to the intensity of the inflammation, from a thin serous to a thick mucous discharge—this constituting the second stage of inflammation. If the inflammatory action increases and the leucocytes form a part of the exudate, we have the third, or suppurative, stage.

In acute inflammations the quantity of mucus is largely increased over that of the normal flow; but in the chronic processes the apparent increase may be, as Bosworth[3] suggests, a diminution, owing to the fact that the normal secretion of serum which serves to dilute the mucus in health, and which disappears by evaporation without being noticed by the patient, is diminished when the membrane is inflamed, leaving behind a thick mucous discharge which soon makes itself evident.

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[1] *Medico-chir. Trans.*, vol. lxxviii.

[2] *Journal of Laryngology*, Nov., 1896.

[3] *Op. cit.*, p. 101.

Croupous and Diphtheritic Inflammation.—The other forms of inflammation met with in mucous membranes are the diphtheritic and croupous. In both of these affections, the exudate, instead of being fluid as in the catarrhal variety, is characterized by a membranous deposit. Occasionally we meet with conditions characterized by pseudo-membranous deposits caused by irritants, non-microbic in character, such as steam, ammonia, and chlorine.

Until within recent years the two diseases known as croup and diphtheria have been considered as separate and distinct affections; but since the advances made in bacteriological research there is a tendency to consider them as one and the same affection. Clinically, they are similar only in the sense that both are characterized by the formation of a membranous deposit. True croup lacks many of the constitutional symptoms of diphtheria, such as the high temperature, septic infection, and the frequent serious sequelæ of the latter affection. The confusion of these two affections has been caused by finding the Klebs-Löffler bacillus, the cause of diphtheria, in the croupous deposit. When we consider that this bacillus is frequently found in the throats of patients who are not suffering from diphtheria, we are forced to the conclusion that their presence in the croupous deposit is either accidental, or, as Moritz Schmidt[1] suggests, these two affections may bear the same relation to each other as do tuberculosis and lupus of the skin.

Nasal Obstruction.—Thus far we have considered the pathology of simple inflammations of the mucous lining of the upper respiratory tract. There are other conditions, however, whose pathology is not so readily explained. In order to understand the so-called obstructive affections of this region, it will be necessary to make some reference to the physics of the nose and its relation to the rest of the respiratory tract. Without encroaching too much upon the domain of physiology, it will only be necessary to refer to the nose as a respiratory organ, the significance of which has only within recent years been fully appreciated; one of its principal and most important functions being to heat and moisten the external air on its way to the lungs. When from any cause this function is interfered with, mouth-breathing results with all its accompanying evils. The disturbances which mouth-breathing produce are the more serious the younger the subject and the longer the existence of the interference with the free passage of air through the nose. The conditions which give rise to interference with free nasal respiration are obstructive in character, and they may result from congenital or acquired closure of the nostrils; from paralysis of the alæ nasi; from hypertrophy of the inferior turbinal bodies, or of the lymphoid tissue in the vault of the pharynx; from ecchondrosis, exostosis, or deflections of the septum; from polypi and granulation tissue, resulting from suppurative inflammations of the accessory sinuses; or from foreign bodies. The effect of these nasal obstructions on the rest of the respiratory tract is to render the subject prone to attacks of pharyngitis, laryngitis, and tracheitis, which when once established are liable to become chronic.

In obstructions resulting from hypertrophy of the inferior turbinal bodies there is generally an antecedent chronic rhinitis, producing a congestion and swelling of the erectile tissue sufficient to produce a temporary stenosis of the nasal chamber. Among other causes for nasal stenosis may be mentioned the constant inhaling of irritating vapors, which causes a chronic congestion and swelling of the parts. Bosworth,[1] on the other hand, believes that these cases in the majority of instances are dependent upon septal deformity, either as a deflection or projecting spurs, tracing the origin of these etiological factors back to infancy, when the child received a blow on the nose sufficient to produce the deformity. There is no doubt that septal deformities, either in the shape of deflections or projecting spurs, are in a large number of cases associated with hypertrophy of the inferior turbinals, although they are not always present. Wherever these stenoses are situated, the atmospheric pressure behind the obstruction has become diminished, and in consequence a chronic congestion is produced.[2] This, of course, means an increased nutrition of the body with a resulting hypertrophy, in which there is an increase of all the tissues which go to make up these bodies, viz., the epithelial and fibro-elastic layer, and the submucous tissue containing the racemose glands and venous sinuses. The degree of hypertrophy varies, in some cases being very slight, not causing sufficient obstruction to the respiration to attract the attention of the patient; while in other instances the increase in size is sufficient to block up the nasal chambers and occasionally to project backward, presenting tumefied masses in the naso-pharyngeal space.

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[1] *Die Krankheiten der oberen Luftwege*, p. 369.

Septal deformities may be either deflections or in the form of ecchondroses or exostoses. They may originate either as a result of traumatism or from an inflammation of the mucous membrane. Traumatism in early youth or infancy plays no doubt a most important part in the production of these deformities, but I believe it is by no means the frequent cause that is so generally assumed. It may happen that these injuries in infancy are readily overlooked or forgotten; but when they do not occur until later in life, an injury sufficient to produce a marked bending of the septum is not apt to pass entirely out of the memory. These conditions have their beginning in the infancy or early life of the subject. When such a person is exposed to cold a catarrhal inflammation of the lining membrane of the nose sets in, with a resulting nasal stenosis. This, of course, acts in the same manner as in hypertrophic rhinitis by producing a rarefaction of the air posterior to the stenosis, with a resulting hyperemia which eventually becomes chronic. The consequence is an increased nutrition of the parts with, in the case of the cartilaginous portion of the septum, a production of cartilage-cells beneath the mucous membrane. This production of cells continues as long as the irritation lasts, and there is a distinct projection from the septum into the nasal chamber known as an ecchondrosis. The same process holds true for the vomer, when the projecting process or tumor is composed of bone, and is known as an exostosis. They may exist either alone or the one may be continuous with the other, and they generally have their starting at the sutural junction between the triangular cartilage and the vomer. Occasionally we find them without any deflection of the septum, but in the majority of cases there is some decided bending to the side corresponding to the ecchondrosis or the exostosis. Syphilis is also, in my experience, a common cause in the production of these conditions.

The deformities resulting from deflection of the septum are not so readily explained. It is occasionally congenital, and in many cases it results from traumatism, but this is not so common an etiological factor as to explain this very frequently occurring deformity. Inflammations explain the process of bending in a few cases by the weakening of the septum, the atmospheric pressure being greater on one side than on the other at some period of the process causes it to bend in the direction of the least resistance. In most instances it is the result of a physiological process—the septum being fixed between two unyielding planes, bends to one side or the other in order to make room for its increased growth.

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[1] *Op. cit.*, p. 125.

[2] [Despite the authorities supporting this view, it seems overdrawn.—Ed.]

Adenoid Hypertrophy.—Situated in the naso-pharynx, pharynx-wall, and at the base of the tongue there is a certain ring of tissue, similar in structure but differing from the neighboring tissues of the upper respiratory tract, which plays a very important part in the pathology of the diseases of this region. While all the lymphoid tissue forming this ring has a striking similarity in structure, there is a decided difference as regards its life-history when diseased, in that the tissue in the naso-pharynx shows a tendency to atrophy at puberty, while that in the fauces and lingual region may continue into adult life; indeed, the lymphoid tissue at the base of the tongue is rarely diseased until after puberty. This brings us to the consideration of the next and probably the most important form of obstructive disturbance met with in the upper respiratory tract, and that is hypertrophy of the lymphoid tissue in the vault of the pharynx. This affection has been variously described as enlargement of the third tonsil and adenoid vegetations. It has been recognized for many years, but it was left to the late Prof. Wilhelm Meyer[1] to point out the frequency of its occurrence and its clinical importance. It is essentially a disease of childhood, occurring occasionally at the earliest periods of life. While it shows a tendency to disappear at puberty, it is frequently observed in adults. Although this affection cannot properly be said to be due to heredity, it is nevertheless observed as occurring very frequently in families with the so-called lymphatic temperament. Several members of the same family may be afflicted in the same manner, all showing a tendency to hypertrophy also of the faucial and the lingual tonsils.

Climate has a very decided influence in the production of this condition, it being much more frequently observed in cold, damp countries than in those where the atmosphere is warm and dry.

Probably the most frequent cause of the hypertrophy of this tissue is frequent and neglected attacks of catarrhal inflammations of the nose and naso-pharynx. The lymphoid tissue becoming once inflamed, shows a tendency to continue and become chronic through the same agencies that produce hypertrophy of the inferior turbinal bodies, with which it is very frequently associated. Among the other exciting causes may be mentioned diphtheria and the exanthemata.

The stenosis resulting from an acute catarrhal rhinitis, or from that due to one of the previously mentioned obstructive nasal disorders, may be sufficient to excite a hyperemia and swelling of the post-nasal lymphoid tissue by rarefying the air in the naso-pharyngeal space. This congestion resulting from lessening of the atmospheric pressure in this region causes an increased nutrition of the tissue with a consequent hypertrophy of its constituent elements.

In the faucial lymphoid tissue there are several distinct pathological conditions recognized, viz., the acute inflammations, which may involve only the mucous covering of the gland or extend into the follicles, giving rise to the croupous or follicular variety; or the whole gland may be involved, and, going on to the suppurative stage, result in abscess of the tonsil or peritonsillar tissue. In the chronic form we recognize the hypertrophic variety, and, according to the classification of Bosworth, the hyperplastic, which is in reality an advanced stage of the hypertrophic form.

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[1] *Hospitals Tidende*, Copenhagen, Nov., 1868.

The croupous variety is a simple inflammation of the follicles that go to make up the gland, infectious in character, and manifested by a thick deposit making its appearance at the mouths of the crypts, and occasionally spreading out as a membrane on the surface of the gland. This exudate is soft and easily wiped away from the tonsil, when it can be seen exuding from the mouths of the follicles. In the hypertrophic variety of tonsillitis there is an increase in all the tissues that constitute this gland. The follicles occasionally become overdistended with secretion, giving rise to a constant fetid discharge from the gland. In the hyperplastic variety there is an increase in the connective-tissue elements, with a gradual destruction of the lymphoid tissue proper. In these cases the gland becomes hard and fibrous in character.

The lingual tonsil situated at the base of the tongue is liable to be affected by any of the pathological conditions mentioned as affecting the other lymphoid glands ; but it is much more rarely affected. It is essentially a disease of adult life, and may have for its origin any of the infectious diseases ; but it is more frequently associated with some form of gastric disturbance.

SYMPTOMATOLOGY.

Many of the diseases affecting the naso-pharyngo-laryngeal tract have symptoms which are common to one or more of them, and in a general way they may be either subjective or objective—the former relating to the disturbance of functions of the organs affected, while the latter are such as can be seen by the observer only.

Obstruction to nasal respiration, resulting in mouth-breathing, is one of the most prominent symptoms among nasal disturbances, as previously set forth.

Occasionally the patient will be found to insist that he has perfect nasal respiration, especially when the intranasal obstruction is not sufficient to make a very decided impression on him, but careful questioning will generally elicit the further information that he awakens in the morning with the mouth open and dry, and that there is snoring during sleep. This symptom is probably more frequently noticed in children who are also very restless during sleep, frequently awakening and calling for water to moisten their parched throats. When the mouth-breathing has existed for some time most decided changes are noticed, not only in the soft parts, but also in the bony frame-work of the mouth and chest, which are more severe the younger the individual. The features are relaxed and assume a well-recognized indolent and stupid expression.

Disturbances of speech, such as stuttering and imperfect articulation, are also frequently observed.

Headache is a common symptom noticed in many forms of intranasal disturbances, especially when resulting from the pressure on the soft parts of bony or cartilaginous projections from the septum, from pressure due to swelling of the middle turbinals, and in inflammatory conditions of the accessory sinuses.

Loss of memory and lack of mental application to the extent of being unable to concentrate the attention upon any one subject are symptoms frequently observed in these nasal and post-nasal disturbances. It is especially noticeable in children suffering from hypertrophy of the post-nasal lymphoid tissue. These little subjects frequently get the reputation unjustly of being stupid, when their mental inactivity is entirely due to some form of nasal obstruction. This is the condition described by Guye of Amsterdam as aprosexia.

Nocturnal enuresis is a symptom so frequently associated with nasal obstruction in children, especially that resulting from lymphoid hypertrophy, that its concurrence can scarcely be called accidental. Grönbech,[1] cited by Scheeh, out of 192 cases of hypertrophy of the post-nasal lymphoid tissue, found enuresis 24 times. Twelve of these cases were cured after operation.

The Palate and Teeth.—A brief reference in this place may be made in connection with mouth-breathing to the changes in the arch of the hard palate, which in the very young becomes altered, assuming an acute bow or V-shape. This deformity results from a combined pressure of the buccal muscles exerted on both sides and a column of air constantly striking the hard palate. Körner distinguishes between the alterations of the upper jaw of children who have suffered from nasal stenosis before the shedding of the deciduous teeth, and those which result from nasal stenosis during the change of teeth. In the first instance there occurs generally the cupola-shaped elevation of the palate; the alveolar border which naturally forms a semicircle assumes the form of an ellipse; but there is no change in the position of the teeth. If the nasal stenosis exists at the time of the change of the teeth, then the lateral alveolar borders are approximated while the anterior border is pushed forward, and the high arch of the palate increases until it encroaches upon the cavities above. The teeth in these cases assume a very irregular shape.

Diseases of the ear frequently accompany nasal and post-nasal disorders, and vary from a simple occlusion of the Eustachian tube, resulting from an acute rhinitis, to a severe suppuration of the middle ear, with all its dangerous sequelæ. Children suffering from hypertrophy of the post-nasal lymphoid tissue frequently exhibit various degrees of deafness, varying according to the size of the growth from a slight diminution of the hearing to almost complete deafness.

Loss of smell, varying from a slight impairment to a complete loss of the function, known as anosmia, may accompany almost any form of intranasal disturbance involving the upper part of the nose; but it is most frequently associated with development of polypi and other inflammatory conditions of the ethmoid bone. In many cases where there is a loss of smell there will also be observed some disturbance in the function of taste. While the taste may not be absolutely lost, it will often be found very much diminished for the perception of flavors.

Voice.—The influence of nasal diseases is frequently observed on the voice, the obstructive affections of the nose and naso-pharynx modifying its tone and rendering articulate speech thick or muffled and difficult to understand. These defects are occasionally observed in paretic conditions of the soft palate which so often accompany disorders of the nose and naso-pharynx, giving the voice a nasal character, so that it is difficult at times to distinguish it from that due to nasal stenosis. The pronunciation of certain consonants under these conditions is considerably modified; for example, *d* sounds like *n*, and *b* is similar to *m*, while the sound of *g* is very difficult to make. It frequently becomes a nice point to decide whether the cause of these speech-defects lies within the nose, naso-pharynx, or is of central origin.

In laryngeal affections the voice may be natural in speaking and altered only in singing, breaking in the passage from the lower to the higher registers. It may be hoarse or uncertain, being natural at times and husky at others, or it may be entirely absent as in aphonia. The respiration may be seriously embarrassed both in nasal and laryngeal affections. In the former it may be obstructed by either acute swelling or hypertrophy of the turbinal bodies, hypertrophy of the post-nasal lymphoid tissue, deformities of the septum, or by new formations within the nasal cavities, such as polypi.

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[1] *Sitzungsberichte des Aerztlichen Vereins*, Munich.

Respiration.—In laryngeal affections the respiration may be more or less embarrassed, hurried, or retarded, according to the nature of the affection. It is often accompanied by a loud noise which may be either stridulous or stertorous in character—the former generally accompanying inspiration, when it indicates some laryngeal obstruction resulting from new formations or foreign bodies, spasm of the laryngeal muscles, false membranous deposits, or paralysis of the abductor muscles of the vocal cords; while stertorous breathing more frequently accompanies expiration and is associated with general paralytic conditions.

Cough is a common symptom of diseases of the larynx, varying in character according to the location and intensity of the inflammation from a simple hacking cough or clearing of the throat to one that is hoarse, barking, or metallic in sound. It may occur in paroxysms and is frequently suffocative. Cough is also a not infrequent symptom of diseases of the nose and naso-pharynx, when it is said to be reflex in character, and due to some pressure on the sensitive nerve filaments in these regions or to an undue irritability of certain sensitive areas, as in the auditory canal, which when irritated give rise to an annoying form of paroxysmal cough.

Deglutition in diseases of the upper respiratory tract may be either difficult, a condition known as dysphagia; painful, odonphagia; or at times impossible, aphagia.

While dysphagia is not a symptom very common to nasal affections, it nevertheless occurs occasionally in those cases where there is a decided enfeeblement of the soft palate resulting from nasal and post-nasal inflammations. It is much more frequently observed in those cases in which the pharynx and larynx are involved, especially where there is obstruction in the fauces, pharynx, or esophagus, or where there is any ulceration or destruction of the velum, either with or without an enfeeblement of the nervo-muscular control of the constrictor muscles of the pharynx. It frequently happens in such cases that the food passes into the nares. Occasionally also, when the epiglottis is either ulcerated or destroyed through the action of syphilis or tuberculosis, the food has a tendency to pass into the larynx until the parts so adapt themselves as to enable it to follow the natural channel into the esophagus.

Odonphagia is associated with nearly all the acute inflammatory affections of the pharynx, particularly tonsillar inflammations, and also with many of the chronic conditions of the larynx, such as tubercular laryngitis, especially when the epiglottis is involved; or when this organ is the seat of malignant disease.

Aphagia is generally present when the larynx or the pharyngo-laryngeal tract are the seat of malignant disease, and results either from the act of swallowing being so painful that the patient refuses to swallow, or the obstruction is so marked that it cannot be overcome.

Under the heading of objective symptoms or those revealed to the physician by the various methods of examination, may be mentioned a change in the color, form, position, and secretion of the parts studied.

The color may be increased or diminished according to the nature of the disease, being increased in all affections of an inflammatory nature, the intensity varying in degree according to whether the parts are the seat of an acute, subacute, or chronic inflammation. It is frequently diminished in those cases where there is general anemia or a marked depression of the heart's action.

It may be altered when the patient is suffering from such general conditions as jaundice, when the membrane assumes a decidedly yellow hue, or from tuberculosis in its early stages, when the membrane frequently presents a grayish appearance.

The **form** may be changed by an increase of tissue, as in the hypertrophic form of inflammation so often noticed in the nasal and naso-pharyngeal cavities, or by a decrease of tissue, such as is observed in atrophic rhinitis. In the larynx the lining membrane may be the seat of a serous, purulent, tubercular, syphilitic, or malignant infiltration, sufficient at times to encroach upon and diminish the caliber of the glottis to a marked degree. The size and shape of the glottis may be changed by the several positions assumed by the vocal cords in the various paralyses of the intrinsic muscles of the larynx. The position of the nose may be altered by any morbid growth springing from within the nasal cavity, but otherwise it is rarely changed. The larynx, however, is very frequently displaced from its normal position by such extra-laryngeal affections as bronchocele, cancer, or enlarged glands of the neck; while contraction of the cicatricial tissue resulting from syphilitic ulceration in many instances disturbs the normal relation of the parts within the cavity.

METHODS OF EXAMINATION AND DIAGNOSIS IN AFFECTIONS OF THE NOSE AND THROAT.

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Before proceeding to the examination of the interior of the nose and throat, it is always of importance to look critically at the face and neck of the patient and also to try to get as much preliminary information as possible by external palpation. This often furnishes valuable clues and hints which are quite likely to be overlooked if they are left until after the internal examination. Look at the region of the frontal sinuses and see if there is any prominence or tenderness on either side; look at the conjunctivæ; feel of the nasal bones with reference to depression or abnormalities of any kind. The degree of mobility of the cartilaginous septum and the presence of deviations and large perforations can be felt by the fingers on the outside. The *alæ nasi* should also be tested as to their strength or flaccidity. The folds and creases about the nose are often indications of muscular action which has for its object the opening of the nostril by drawing the ala away from the obstructing septum. Notice whether the mouth is habitually closed, the shape of its aperture, the dryness of the lips, whether the teeth or jaws overlap. Always feel for enlarged glands of the neck both in front of and behind the sterno-mastoid muscle. The neck should be thoroughly relaxed, otherwise the glands are not easily reached.

Inform yourself as to the condition of the ears, especially as regards the existence of suppuration. The hyoid bone and the thyroid and cricoid cartilages are to be examined and any enlargement of the thyroid gland noted. Move the larynx from side to side to test its mobility and the amount of creaking on the prevertebral structures and also to see if there is any tenderness. The finger placed lightly on the crico-thyroid membrane detects the narrowing of the crico-thyroid space when the pitch of an emitted note is raised.

According to Gerhardt,[1] very important deductions can be drawn as to paralysis of the larynx by external palpation alone; but it is not my purpose here to do more than point out the advantages of a thorough external examination as a matter of routine practice before beginning internal examination.

As regards the latter, the nose should always be examined first, then the mouth and post-nasal space, and lastly the larynx.

EXAMINATION OF THE NARES.

For illuminating the nose and throat we have at our disposal diffused daylight, sunlight, candle, oil-lamp, gas, the Welsbach burner, electric light, oxyhdrogen light, and perhaps acetylene gas. Ordinary daylight is not strong enough for the nose or post-nasal space, and is too uncertain and

[1] *Archiv für Laryngol.*, vol. ii. p. 281.

variable. Sunlight has the merit of bringing out in their natural colors the various structures examined, but it also has many drawbacks. Its change of position, intervening clouds, and various obstructions on the earth render it very unreliable. With the concave head-mirror the rays are easily brought to a focus, and a burn may result unless we are careful to keep the illuminated area beyond the focal distance. In order to change the direction of the rays and make them more horizontal and thus better adapted for reflection by the head-mirror it is well to have them caught by a plane mirror at the window, which will reflect them at any required angle to the head-mirror. The power of the sun's rays is so great that, in spite of many drawbacks, it certainly illuminates and brings out most vividly the various tissues under examination.

The electric light is used either as a small lamp attached to the head or as a lamp fastened to the wall or table, and the rays are reflected by the head-mirror. The head-lamps have always seemed to me to be heavy and cumbersome and to have no special advantage. In the other form of lamp the light is often not bright enough and the film casts a disturbing shadow.

I have seen the oxyhydrogen light is some European clinics, but it is bulky, expensive, and not easily managed. It is used as a direct illuminant and not reflected by a head-mirror, and we shall see particularly as we examine the nose, that it is very essential to focus the light quickly at varying depths, and that in so small a space the axis of vision and of illumination should be the same and a head-mirror is indispensable.

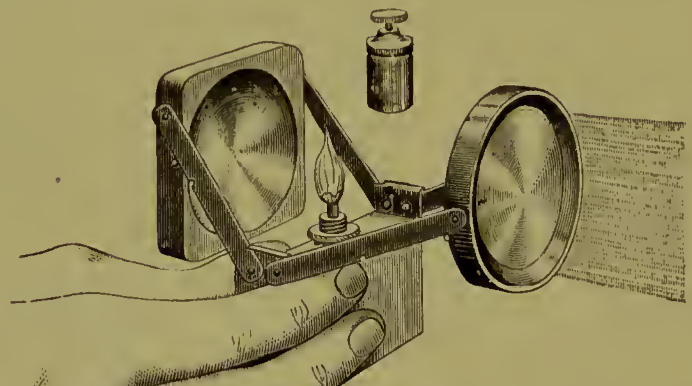

FIG. 552.—Folding lamp for laryngoscopy, ophthalmoscopy, and other uses.

An oil-lamp with a bright flame, such as the Rochester burner, or even the ordinary student's lamp, is to be recommended where there is no gas, the principal objection being the heat; but for everyday work nothing has proved itself so well suited for our purpose as gas with the Argand burner. Gas has also an advantage over the electric light in that with it we can warm our mirrors and instruments, fuse medicines upon probes, etc. The Welsbach burner gives a very brilliant light, and it is unfortunate that it is so fragile, especially when used with adjustable fixtures. The light from acetylene gas is very powerful, and objects illuminated by it look more as they do by daylight than when ordinary gas is used, but it is hardly yet available.

One of the best fixtures for gas is the adjustable arm-bracket attached firmly to the wall. This can be raised or lowered and moved in any direction. Where the light is to be on a table at a distance from the wall a movable gas-lamp with an adjustable arm is excellent. A very good little portable lamp, very compact, easily carried, and well adapted for use at the bedside is the one figured (Fig. 552).

It is advisable to have a dark chimney with a bull's-eye condenser to concentrate the light and make it more powerful, and I have found the Mackenzie condenser very satisfactory (see Fig. 553). The room need not be dark, but no strong light should shine on the patient's face. He should sit in a wooden chair with a fairly straight high back without arms. For operation, a head-rest can be attached to the back, against which the head can be pressed. Women sometimes like to have a small cushion behind the shoulders or back of the head, especially if the examination is at all prolonged. The clothing about the neck should be loose, and there should always be a handkerchief in the hand and nothing else. The use of instruments is so likely to cause a flow of mucus, sneezing, gagging, etc., that a handkerchief may be needed suddenly at any moment. The hands should be in the lap, and the arm should not rest on the table, because this forces up one shoulder and makes the examination harder. The position should be an easy, natural one and without any tendency to rigidity of the neck.

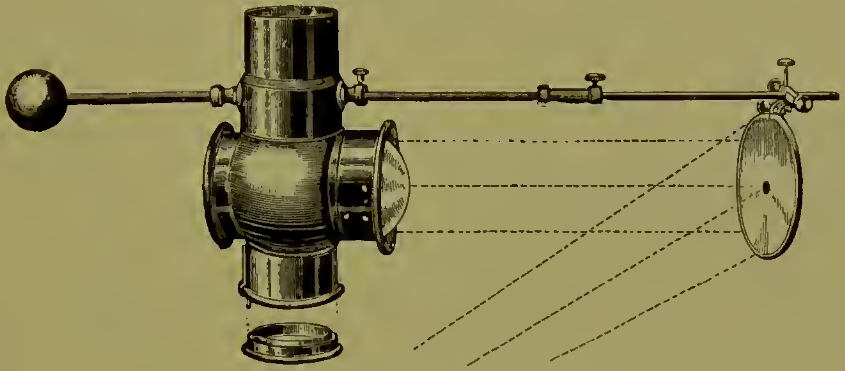

FIG. 553.—Shade and condenser.

The light should be on the right of the patient, on a level and about on a line with his mouth, and far enough away from the head so that the heat is not annoying—about nine inches—and when not actually in use had better be turned down. On the left hand, at a convenient height, should be some form of spittoon. The doctor sits directly opposite the patient on a light, but firm stool, with his knees outside those of the patient.

I have already spoken briefly of what we should look for externally. Notice the size and shape of the nostrils, see if the fleshy septum is directly under the cartilaginous septum, or if the latter projects anteriorly into one or the other nostril. Look for dilated capillaries where the septum presses against the skin, for cracks, fissures, skin eruptions. Try the strength of the alæ and see if there is a tendency for them to collapse or fall in and block the nose by a valve-like action.

In testing the patency of the nostrils place the finger under the opening in such a way as not to displace the parts. The sound made by the expelled air shows more or less accurately the amount of obstruction in the nose. If an oily liquid is blown into one nostril by a vaseline atomizer it should come out of the other in nearly equal volume if both nostrils and the postnasal space are free, but obstructions in or behind the nose diminish the amount of the escaping vapor in proportion to the degree of obstruction. If a piece of finely frayed-out absorbent cotton is held lightly in front of each nostril the amount of motion imparted to the cotton by the air as it comes out of the nose will show to a certain extent the perviousness of the nose. This method is often of use to demonstrate that, for instance, in the case of a child asleep with mouth wide open, most of the air goes through the nose and very little through the mouth. Hold the cotton in front of the mouth and then near the nostrils, and the movement of the cotton may be much less by the air from the mouth than from the nose, even when the post-nasal space is much blocked and the mouth is wide open. This is a very forcible way of showing to parents that the mouth is not doing the work of the nose.

A graphic idea of the perviousness of the nostrils can be obtained by holding a cold glass mirror horizontally under the nostrils on a level with the upper lip and noting the size and shape of the moisture which condenses on the glass on exhaling through the nose. The length of time that it requires for the moisture to disappear is also a factor in determining the degree of obstruction, the vapor from the narrow side disappearing first.

The sense of smell is tested in a general way by holding to the nostrils various volatile substances of different strengths as regards their odor and noting how they are perceived by the patient. For more accurate measurement, an instrument devised by Zwaardemaker and called an olfactometer can be used. This consists of a glass tube *C* (see Fig. 554), whose bent end fits into the nostril. This slides in a cylinder *T*, which is made of the odorous substance or is impregnated with it. When the tube *C* is pushed to the end of the tube *T*, the inspired air contains no vapor, but the more the tube *C* is drawn out of the tube *T*, the more the inspired air will be exposed to the inner side of *T*, which is odorous. The distance to which *C* has to be drawn out before the odor is perceived, and which is indicated by the scale marked on the glass, gives the measure of the acuteness of smell. Tubes impregnated with different volatile substances are used, and the temperature of the air should be borne in mind, as the warmer the air the more volatile the substance. The perception of an irritation of the nasal mucous membrane by vapors, such as ammonia, or powders, should not be confounded with the sense of smell.

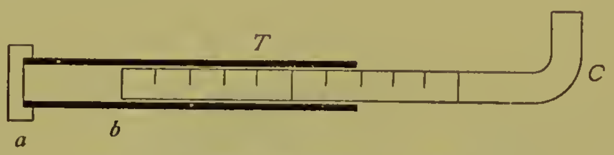

FIG. 554.—Zwaardemaker's olfactometer.

For illuminating the interior of the nose it is necessary to have a concave mirror to concentrate the light and project it in any required direction. The early mirrors were larger than many of those now in use, but possessed no advantages from their size. One with a diameter of 3½ inches is large enough, and the lighter it is the better. Thin glass and an aluminum back diminish the weight. A large open eye-hole gives a much bettter view than a small one. The head-band should be firm but not elastic. The Schrötter band with the two knobs to rest on the nose causes an unpleasant feeling of weight and pressure, and to my mind is much inferior to the simpler ones which have a padded piece to rest on the forehead over the eye. One that gives a firm support, is light, and can be folded together and over the mirror, making it safely portable, is to be preferred. An open wire band to go over the vertex and take support under the occiput is thought by some to cause less heat and fatigue than the solid bands. The perforated hard-rubber band, shaped to the head, made by Pfau of Berlin, has the advantage of being clean, and the weight of the mirror is distributed over the whole circumference of the head. The ordinary band absorbs the perspiration and in warm weather can become foul and irritate the skin.

The mirror is usually worn over the right eye, although some prefer it over the left, claiming that it thus protects the examiner's eyes better from the glare of the lamp. It can be attached to a rod fastened to the lamp, and its weight is then entirely removed from the head (see Fig. 553). This is not a good arrangement for examining the nose, because it is necessary to move the patient's head up and down and in various directions, and the opening of the nose is so small that a slight movement of the head throws the light away from the nose and the position of the mirror has to be changed constantly by the hand. For the tonsils and pharynx and also for the larynx, when the latter is easy to see, it is more useful, because slight movements of the patient's head do not remove the light from the throat.

The nasal specula most commonly used are those of the bivalve, duck-bill, and the open wire type, with their various modifications. The open wire specula have certain disadvantages; they do not hold the hairs out of the way, they have almost no reflecting surfaces, and they cut into the nose. Some of them, Bosworth's, for example (one of the best), are self-retaining in certain cases, and are useful as retractors in operating in the front of the nose, but are not so well adapted for examining the middle and posterior parts.

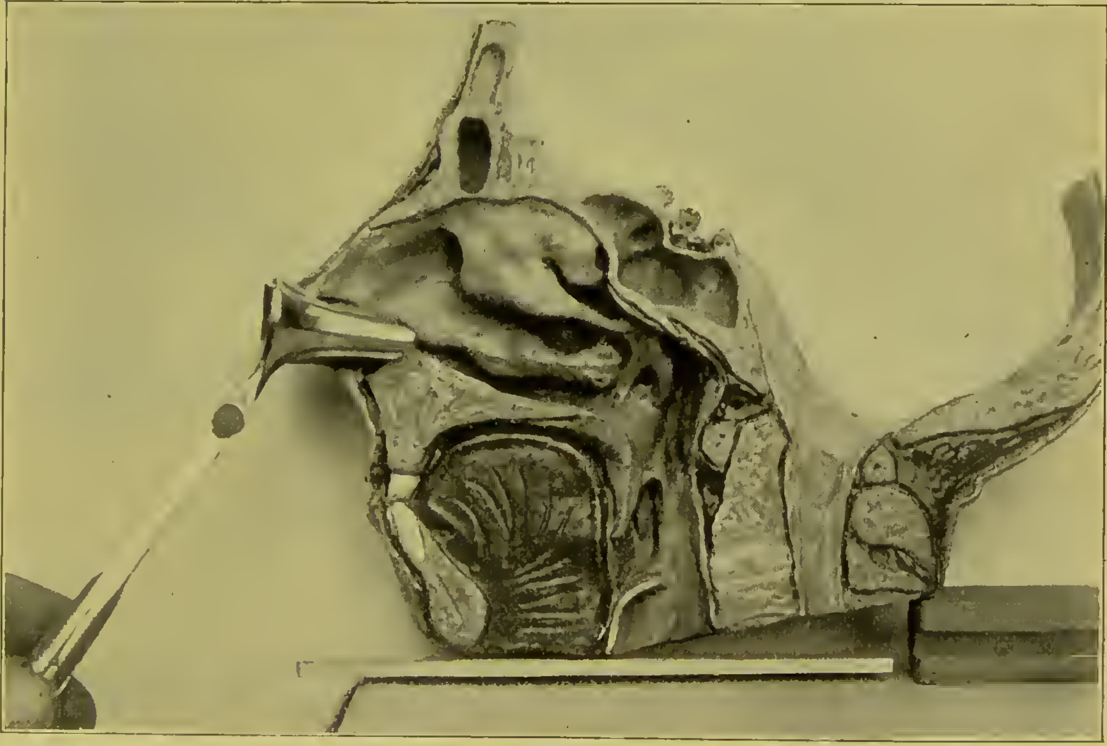

FIG. 555.—Hartmann's bivalve speculum as held for the study of the inferior turbinal and meatus (in a cast of the opened nasal chamber).

The duck-bill specula, of which Duplay's is one of the most generally used, are light, have good reflecting surfaces, thus lighting up well the deeper portions of the nostrils, hold the alæ and the hairs well out of the way, and do not cut into the nose. They do not allow the passage of large instruments through them, and in some cases are not well adapted for operations, but for examinations they are excellent.

Of bivalve specula there are many varieties. I have always considered that Hartmann's (Fig. 555) answered its purpose very well. A firm even expansion of the nasal orifice can be made with it, and it has good reflecting surfaces and allows the passage and manipulation of good-sized instruments. The blades are sometimes made too thick.

As a simple retractor of the ala a bent hairpin can be used and can be held in place by a tape fastened to it and then tied around the head. A nasal probe is indispensable for exploring the cavities and estimating the density and mobility of the various structures. It should be long enough to reach the posterior pharyngeal wall easily through the nose and fairly stiff. I have used with satisfaction one like Fig. 556. It is five inches long from the tip to where it bends downward at the handle. All instruments should be warm and used very gently.

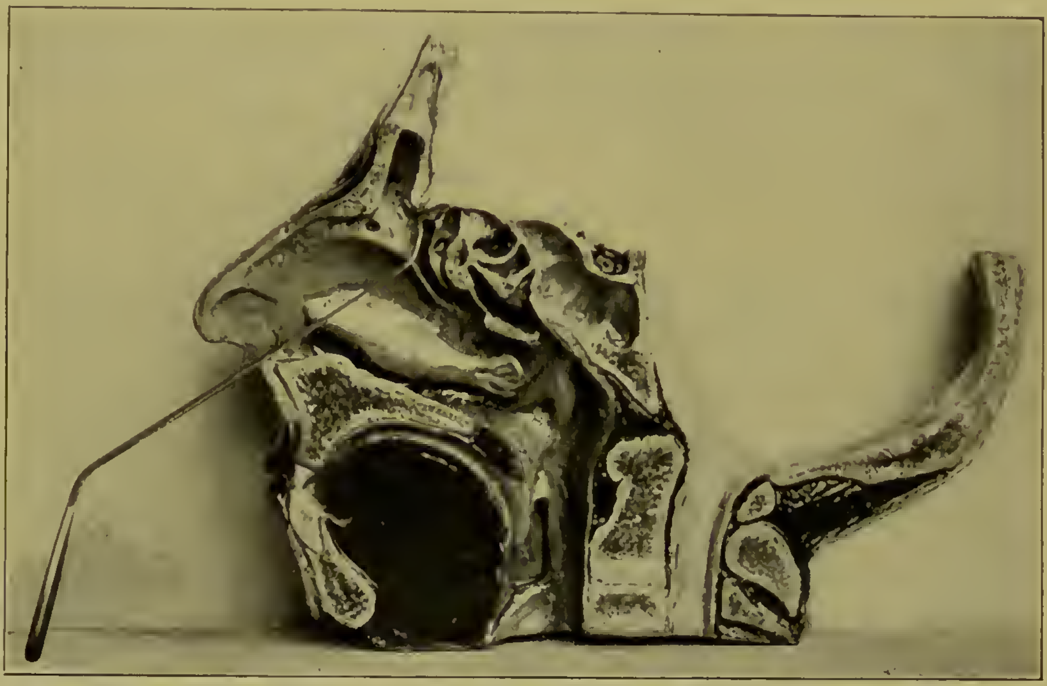

FIG. 556.—Nasal probe inserted into semilunar hiatus and infundibulum of a cast of the dissected nasal chambers.

In order to get better access to the interior of the nose its tip should be lifted up by the finger so as to get a view over the anterior projection of the floor of the nose. The speculum is introduced closed, one blade resting against the septum and the other against the ala, and gradually opened. The anterior septum should be looked at while the speculum is being put in, otherwise the blade may cover small cracks, vessels, or ulcers. Students often overlook small perforations for this very reason. The thin mucous membrane of the septum can be made to bleed very easily by pressure of the end of the speculum, a thing to be carefully avoided.

When the patient's head is straight (see Fig. 555) the most prominent object on the outer wall of the nostril is the red rounded end of the inferior turbinal body, underneath which is the inferior meatus. The opening of the tear-passage into this meatus is not seen, being concealed by the turbinal. We should be able to follow this body along to near its middle and sometimes even to its posterior end, and may even see a portion of the posterior pharyngeal wall. By getting the patient to say *K*, we not infrequently see the soft palate lifted, and if the turbinal is very small, we may see the Eustachian eminence; and the act of swallowing shows the mouth of the tube brought nearer the median line and more into view.

The turbinal is subject to great variations in size from vaso-motor influences, as well as from hypertrophy and atrophy of its tissues. Sometimes it is so large as to fill the whole anterior part of the nostril, and a mere touching with the probe may cause it to diminish perceptibly. Spraying also may have the same effect. We must distinguish between a true and an apparent hypertrophy. The former is quite firm to the probe and does not diminish appreciably in size under the influence of cocain. The turbinal may also be very small, in which case the inferior meatus is usually large and the posterior pharyngeal wall may be plainly seen. It is important to determine whether this smallness is natural or due to an atrophy. If normal, the membrane over it will have the normal color and moisture, and the rest of the nose will be found in good condition. If atrophic, the membrane will be a dull, lusterless red, perhaps rather dry, and there may be crusts or muco-purulent secretions over it or in the rest of the nose. The posterior end of the turbinal is liable to great swelling, which can be determined by the probe from the front, or often better by posterior rhinoscopy, as we shall see.

The head should now be tipped farther back, which brings into view the middle meatus, the usual seat of polypi and the place where the openings of the antrum, frontal sinus, and ethmoid cells are found. Above this is the middle turbinal body, which begins farther back than the inferior, is less rounded in shape, and with its mucous membrane more closely adherent to the bone. It is not seen to such an extent as the inferior, as a general rule, and great hypertrophy of the latter or deviations of the septum may conceal it altogether. If the head is tipped still farther back, we can see the roof of the nose and the olfactory fissure; but the superior turbinal is not visible. The upper regions of the nose are narrow and sensitive, and the probe should be carefully used. As the olfactory nerve is distributed on the upper part of the septum and over the superior and middle turbinates we should notice whether there are any obstructions which would prevent the air from having free access to these important regions and also whether the membrane in which the nerve is distributed is normal or atrophic or covered with crusts or abnormal secretions.

Foreign bodies are usually in the inferior meatus and cause a purulent or even bloody discharge. A unilateral discharge, especially in a child, should always awaken a suspicion of a foreign body, and with the probe we are able to feel and locate it. Necrosis may also cause a bloody, purulent discharge with the characteristic odor, and should be carefully hunted for with the probe, in the upper part of the nose particularly.

On the inner side of the nostril is the septum, made up of the anterior or cartilaginous septum, the perpendicular plate of the ethmoid and the vomer. It is very uncommon to find the septum straight, dividing the nose into two equal nostrils. The cartilage is very frequently bent so as to encroach upon one nostril, or it may have a sigmoid deviation which occludes both nares. Thickenings in the shape of ridges and spurs are common. These may press against the turbinals in such a way as to make it very difficult or even impossible to see far into the nose.

To determine the thickness of the septum we can introduce the little finger into each nostril and estimate the amount of intervening cartilage; or we can make use of the septometer, such as Seiler's, whose scale gives an accurate measure of the thickness of the structures between the ends of the blades.

If the light is thrown into one nostril, especially if it is sunlight, the color of the septum when viewed through the other nostril is much lighter where the septum is thin than in its thickened portions. A probe bent at the end when slid along a ridge or spur will show when the posterior edge has been reached.

The anterior vulnerable septal cartilage is the usual seat of epistaxis, and here we should look for dilated vessels, ulcers, and perforations.

The normal secretion of the nose is clear mucus, more copious in cold weather than in summer. The character and seat of the secretions of the nose should be carefully noted before they are removed by spray, swab, or forceps. Occasionally we meet a case where there is a very profuse and annoying flow of clear mucus which hinders our examination. A small dose of atropin about four hours before the visit serves to check this. Our great resource for obtaining a better view of the interior of the nose is cocain. This causes the turbinals to diminish in size; the amount of blood in the mucous membrane is lessened. This is of special value in hypertrophic conditions where, without it, we could see only the anterior part of the inferior turbinal. The nose should be carefully dried with cotton and a small quantity of a weak solution, say 4 per cent., placed against the tissues which it is desired to diminish in size. This is much wiser than spraying the solution indiscriminately into the nose. When the anterior obstruction is diminished, another application can be made farther in. The nose should be first examined as thoroughly as possible without the cocain; for this, while rendering the deeper structures visible, blanches the tissues and so changes their aspect that we might be entirely misled unless we knew the condition before the cocain was applied.

Yet, even with the help of cocain, we shall find some nostrils so narrow and tortuous and the external orifice so small and even pointing downward that we can get but a very imperfect view of the interior.

ACCESSORY CAVITIES.

Within the last few years the accessory cavities have begun to attract the attention they deserve. The antrum, frontal sinus, and anterior ethmoidal cells open into the middle meatus (see Fig. 556); the posterior ethmoidal cells and the sphenoidal sinus open into the superior meatus. If a discharge of pus is seen in the upper part of the nasal chamber, when not due to necrosis or a foreign body, it probably comes from one of these cavities. In early life they are very imperfectly developed; but in later life, especially since the epidemics of influenza, their diseases are seen to be not uncommon.

The largest and most frequently affected cavity is the maxillary antrum, which has its outlet at the top and empties into the middle meatus by an opening which is usually concealed by the middle turbinal, under which pus from the antrum makes its appearance. If this pus is thoroughly removed and the head bent forward and downward, with the side of the face corresponding to the suspected antrum uppermost, pus will thus more readily run out of the natural opening and can be seen under the middle turbinal when the patient again sits upright.

Transillumination often gives a certain amount of information as to whether the pus is located in the antrum, and should always be tried before making an exploratory puncture. Unless the room can be made absolutely dark, it is well to use a piece of black cloth, such as photographers use in focussing, or a black rubber sheet which can cover the heads of examiner and patient, and when tightly held under the chin shuts out effectually every ray of light. A small electric light (Heryng's is good, but there are a number of others) is placed in the mouth above the tongue and the lips are tightly closed. All tooth-plates should be removed. When the electric light is turned on, the healthy antrum should allow the light to pass through it and show a crescentic bright area under the eye, and sometimes the pupil is lighted up (see Plate 14). The patient should also have the subjective sensation of light in the eye with the eyes closed. In case the antrum is filled with pus or any opaque substance, this area and sensation of light are entirely wanting. This method is often of great value as corroborative evidence; but too much reliance should not be placed on it, because there are cases in which the face fails to be lighted up when the antrum is empty, even when the bony walls are not abnormally thick. But I think we may safely say that where there is a discharge of pus under the middle turbinal and that side of the face remains absolutely dark without sensation of light in the eye, while the other side is brightly illuminated with sensation of light, the chances are very greatly in favor of our having to deal with empyema of the antrum (see page 970).

To make sure that the antrum is the part affected we can wash it out in various ways. A hollow cannula, such as Hartmann's, can be passed along under the middle turbinal till it comes to the neighborhood of the natural opening and then turned outward, and it can sometimes be felt to enter the opening. A syringe attached to the cannula may be used to suck the pus out, or warm water may be forced in, and the stringy flocculent pus which appears shows its antral origin.

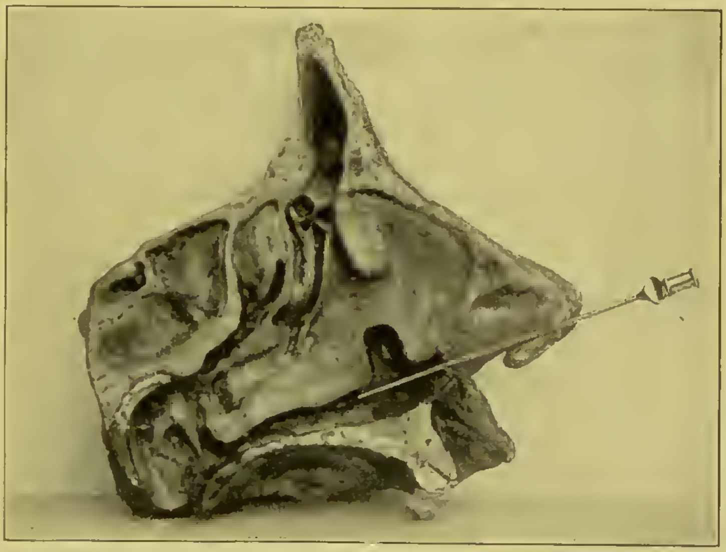

FIG. 557.—Hajek's straight cannula inserted for puncture of the antrum-wall in the inferior meatus (in a cast of the nasal chamber, dissected to show the lachrymal duct, the infundibulum, etc.).

In case the opening is not found, it is possible to perforate the outer wall of the middle meatus with a trocar and wash out through this artificial opening, the pus escaping through the natural opening or one or more accessory openings which may exist. Care should be taken not to puncture too deep for fear of entering the orbit. Cocain should be used for these manipulations, both to produce anesthesia and also to cause a shrinking of the tissues and gain room. It may be necessary to remove the anterior end of the middle turbinate to gain greater freedom for the cannula. Pieces of polypi and granulations, if present, should also be removed.

I have preferred to make the exploratory puncture in the outer wall of the inferior meatus, about the middle third, where the bone is usually thin. For this the curved trocar, such as Krause's or Myles's can be used, or the straight hollow needle of Hajek (see Fig. 557). This is passed along under the inferior turbinate to the proper spot, and is then pointed outward and pushed through the bone into the antrum, when the washing out follows, as above described. If a tooth has recently been extracted, the alveolar socket may be so thin that a cannula can be passed easily through it into the antrum. The alveolar process can be perforated through the socket of the bicuspids or molars or between the roots of the teeth. These latter places, as well as the canine fossa, are generally chosen in carrying out treatment rather than for simple diagnostic purpose.

In case we find that the pus in the middle meatus does not come from the antrum, we should look to the frontal sinus and the anterior ethmoidal cells. The former is reached through the infundibulum by a small hollow sound or cannula (see Fig. 556). This is often difficult, and it may be necessary to remove the anterior end of the middle turbinate. If pus is brought away on the sound when it enters the infundibulum, or if washing out the cavity through the cannula shows pus, the frontal sinus is presumably the seat of disease, as it may be when the antrum is filled by its discharge.

We can also make use of transillumination by covering the electric lamp with a thick piece of rubber open at the end so as to throw the light in one direction only. The rubber is placed against the roof of the orbit, not too near the thick orbital ridge (see Plate 14), and pressed upward, inward, and backward. The healthy sinus may thus be lighted up and show an illumination over quite an area. In case one side is light and the other not, it will give us an intimation that the dark sinus may contain pus. But the frontal sinus is so irregular in contour and size that we must not lay too much stress on this mode of examination.

The anterior ethmoidal cells are entered by passing the probe upward between the middle turbinal and the outer wall into the hiatus semilunaris (see Fig. 556). The opening is near that of the frontal sinus, and the end of the probe should be bent at a right angle.

The opening of the sphenoidal sinus can sometimes be seen when the turbinals are very much atrophied. The anterior wall is usually about seven centimeters from the anterior nasal spine. A probe passed along the anterior part of the floor of the nose upward and backward between the septum and the middle turbinal, crossing the latter a little posterior to its center, should reach the anterior wall of the sinus (see Fig. 555).

EXAMINATION OF THE PHARYNX.

The lips, cheeks, teeth, palate, tongue, and floor of the mouth should be carefully examined for ulcers, cicatrices, fissures, swellings, ranula, tongue-tie, etc.

For the tonsils, pharynx, and post-nasal space a tongue-depressor is necessary. It is possible to get something of a look at the fauces by pressing down the tongue with a spoon, pencil, paper-cutter, the patient's finger, or even without any instrument, the patient saying "*Ah!*" during a deep inspiration, but no thorough examination can be thus made. The depressor of Türck is one of the oldest and has the advantage of resting at the corner of the mouth and is easily held by the patient when the examiner desires to use both hands in examining or operating.

The narrow-bladed depressor of Fränkel is much used and holds down the center of the tongue well and takes up but little room in the mouth. But I have found the sides of the tongue likely to be raised on either side of the instrument, shutting off the sides of the throat and the base of the tonsils from view. It has not seemed to me to take a sufficiently strong hold on enough of the tongue to keep it steady and out of the way. I prefer a broader, thin blade with a fenestrum, somewhat concave from side to side and also from front to back. About an inch in width at its widest part and from 3–3½ inches in length gives a blade which keeps the sides as well as the center of the tongue out of the way (Fig. 558).

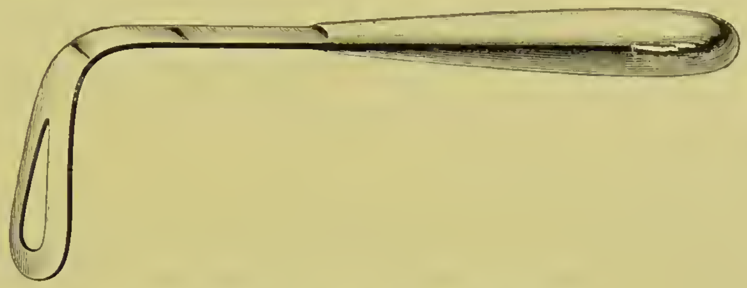

FIG. 558.—The author's tongue-depressor.

In open wire depressors the tongue is very apt to protrude between the wires and obstruct the view; and folding depressors, although portable and convenient, are not always stiff enough.

The proper use of the tongue-depressor is of great importance and is the key to a correct examination of the throat and post-nasal space. The patient should be told to open the mouth, but not too wide, and to keep the tongue inside the mouth, its tip against the lower front teeth. He should then say "*Ah!*" in a natural voice without contracting the throat. When he has said this several times the tongue-depressor is taken in the hand and carried over the tongue till the end of the blade is well over the dorsum where the tongue begins to curve downward, and while "*Ah!*" is being spoken the instrument presses downward and pulls forward the base of the tongue. If the handle is held between the thumb and forefinger, the middle finger placed under the chin acts as a fulcrum and the third and little fingers pull the handle upward and consequently help to depress the tongue still more. With the tongue, chin, and depressor thus firmly held, the patient's head can be moved up or down or sideways, and is well under the control of the examiner (Fig. 559).

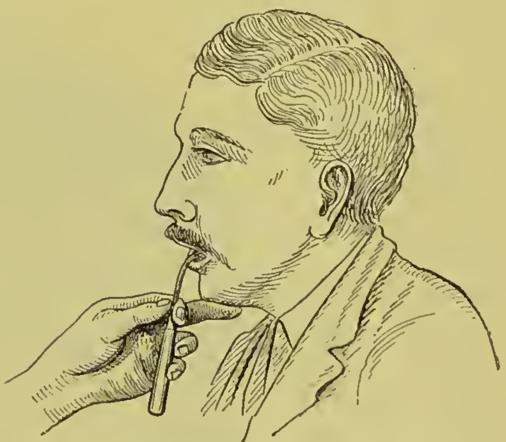

FIG. 559.—Tongue-depressor in position for examining the fauces, with finger under the chin.

There are, however, many cases where this is a very difficult undertaking. A short, thick, muscular tongue requires considerable force to make it lie down; a strong but steady pressure should be used. Some patients have such irritable throats that they gag even before the tongue-depressor touches the tongue. Great patience is needed and many trials. It is sometimes well to endeavor to turn the patient's attention from what you are trying to do by getting him to say "*Ah!*" several times in a loud tone while you try the depressor. Immediately after a meal there is a greater tendency to gagging than when the stomach is nearly empty, and the visit should be timed accordingly. If there is secretion on the posterior pharyngeal wall, it should be removed, because it tends to cause gagging when the tongue is held. The nose and post-nasal space should be freed from secretions, as free nasal respiration makes it easier to have the tongue held. The gagging of the alcoholic may be almost impossible to overcome, and in such cases it is well to try a few doses of bromid. Pieces of ice held in the mouth diminish the irritability.

In case we find our patient still unable to allow a satisfactory view of the throat we can generally succeed by painting the posterior pharyngeal wall with a 5 per cent. solution of cocain. The unpleasant sensation of suffocation and of a foreign body impossible to dislodge soon disappears, and the patient should be told of this. A fairly stiff probe is of great use in examining the tonsils. If passed between the anterior pillar and the tonsil, it shows the presence or absence of adhesions. It should be passed into the crypts to determine whether they contain cheesy secretions or tonsilliths. A dull wire curette is valuable for searching under the anterior pillar and in any deep depressions in or about the tonsil. The probe can also pull the tonsil from its bed and render it more visible and bring out more clearly the size of its attachment to the side of the throat. During gagging the tonsils are everted, approach the median line, and appear much larger than they really are, consequently they should be examined while at rest and in their natural position. If one forefinger is placed under the angle of the jaw and the other in the mouth against the tonsil or soft palate, we can determine the density of the tonsil, whether it contains a hard concretion or a cyst, and also the presence of fluctuation.

POST-NASAL SPACE.

For the post-nasal space we make use of the rhinoscopic mirror, which should have a size corresponding to the distance between the soft palate and the pharynx-wall and also between the uvula and the tonsil. The common size is about half-an-inch in diameter, but for children, especially where the tonsils are large, one-half the size is large enough. In some cases where there is plenty of room and the parts not sensitive, we are able to use a laryngoscopic mirror. The usual angle of the mirror to the shank is about 105°, but mirrors are also made with a joint by means of which any desired angle can be obtained. The head should be held a little forward. After warming the mirror, to avoid condensation of moisture, it should be held like a pencil, the reflecting surface upward and passed parallel to the surface of the tongue until the uvula is reached. It should then be turned diagonally and passed between the uvula and the tonsil, usually to the right of the uvula and then behind and below the soft palate, with the reflecting surface facing upward and forward. The patient should be directed to breathe through the nose and try to say "*en*" with a strong nasal tone.

The view obtained is of a part only of the post-nasal space at a time, and the mirror has to be turned in order to see the different parts in succession. It is very important to have the base of the tongue well pulled forward so as to have plenty of room for this manipulation of the mirror. The landmark for which we look is the back of the vomer, which is of a yellowish gray color, broader at the top than lower down. The middle turbinal is generally more prominent than the inferior, whose lower half and the inferior meatus are often not visible. These structures are lighter colored, more gray, than their anterior ends. High up we may see on one or both sides the small superior turbinals which are not visible through the anterior nares. The mirror has to be turned considerably toward the sides in order to see the Eustachian prominences with their yellowish, crater-like openings, over the edge of which a small red vessel is often seen. Behind the prominences are the fossæ of Rosenmüller, perhaps irregular at the bottom, or there may be bands of adhesion stretching across to the prominences. The pharyngeal vault should be dome-shaped and is often irregular. In the center we may find a cleft, the median recess, whose depth can be told by passing into it behind the palate a suitably curved probe, which can also give information as to the density and extent of any thickened tissues at the vault. The mirror alone sometimes gives an inadequate idea of the amount of hypertrophy at the vault, as will be readily seen by looking at Figs. 560 and 561.

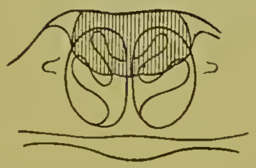

FIG. 560.—Adenoid hypertrophy as seen from the front, showing its true relation.

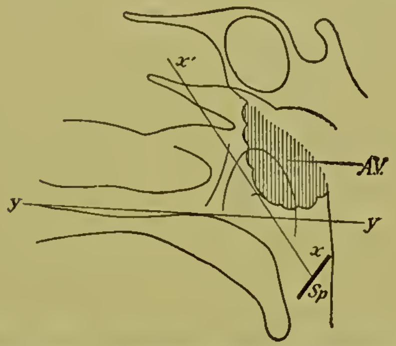

FIG. 561.—The same growth apparently far less dependent, as seen by posterior rhinoscopy (Zarniko).

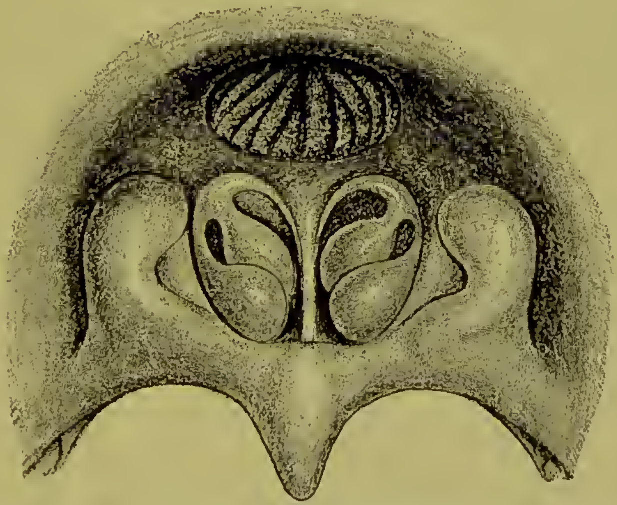

FIG. 562.—Post-rhinoscopic view of the septum, choanæ, Eustachian tube-mouths, soft palate, and pharynx-vault (after Heymann).

We will suppose that there is a growth which reaches down to the lower border of the inferior turbinal. When looked at through the anterior nares we see the growth hanging down as far as the inferior meatus, represented by the dotted line. The rhinoscopic mirror, however, seems to indicate that its lower margin is on a level with the superior meatus, and is consequently of much less extent than it really is. In such a case it is well to hold the mirror more horizontal and look at the posterior end of the growth, if that is possible, when we may find that it hangs down farther than we had first supposed. But a much better way is to make use of digital exploration, as we often have to do when no post-nasal examination is possible. The examiner stands at the side of the sitting patient with his arm around the patient's head, and in the case of a child it is well to press the cheek in between the teeth, which serves to keep the mouth open and also prevents the biting of the examiner's finger. A metal finger is often used as protection against the sharp lower teeth, or a mouth-gag may be employed.

The forefinger of the doctor's hand, the palmar side up, is then passed along the side of the mouth to the tonsillar region and then behind the soft palate, being very careful not to carry the uvula or palate with it. The elbow is well depressed and carried in front of the patient and the finger feels for the septum, turbinates, Eustachian eminences, the vault, and can thus estimate very accurately the amount and character of any obstructions, whether central, near the choanæ, how much of each posterior naris is covered, and whether the growths are on the posterior wall. The examination should be short but thorough, and may be unsatisfactory unless the child is firmly held. It should follow and not precede other methods of examination, because the child has usually had all the examination he will submit to when the finger has once been behind the palate.

Still another way of seeing the post-nasal space is advocated by Katzenstein of Berlin,[1] who calls it autoscopic. The patient lies on his back with the head hanging down as far as possible. The mouth is then opened and the tongue drawn forward, as in laryngoscopy. A palate-retractor, resembling an eyelid-retractor, is then placed behind the uvula, and by slowly and gradually increasing the force used the palate is drawn so far forward and downward that we are able to see the posterior pharyngeal wall, the vault, the Eustachian eminences and openings, the plica salpingo-palatina, the plica salpingo-pharyngea, and the fossa of Rosenmüller. The septum, turbinates, and choanæ are not visible. Post-nasal tumors and adenoid hypertrophy can be seen and operated on in this way without a mirror, and the catheter can be placed directly in the Eustachian tube without having to pass it through the nose. Strong illumination is necessary here, as in all examinations of the post-nasal space.

The obstacles to rhinoscopic examination are many. The tonsils may be so large as to prevent the introduction of even the smallest mirror. A very broad uvula may interfere, in which case we can hold it to one side or lift it by a palate-retractor. The distance between the soft palate and the pharynx may be so small that there is no room for the mirror. By using a little cocain on the back of the palate we may be able to pull it forward by the palate-hook and gain space enough for a small glass.

Where the fauces are of sufficient size the attempt to pass the mirror behind the palate often causes the latter to be drawn back against the pharynx-wall, even when the mirror has not touched the tongue, uvula, or pharynx. The mere presence of the mirror, whether by interfering with the passage of the air or by acting on the mind, is enough to excite movements of the palate. A very small mirror may be tolerated when a large one is not. I have sometimes succeeded by passing the tongue-depressor on the side of the tongue instead of in the center and pushing the tongue over to the other side. Thus room enough is gained near the tonsil for a small glass, and the patient does not have so much the feeling that the tongue is being held down.

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[1] *Arch. f. Laryngol.*, Band v. p. 283.

I have already spoken of the need and value of a weak solution of cocain in the pharynx, and it is also well to paint a little on the back of the palate.

A good many self-retaining palate-retractors have been devised to hold refractory palates out of the way, and that of White is probably as good as any. One end goes behind the soft palate and the anterior branches are placed on the outer side of the lip, one on either side of the nose. I have found, however, that cases that needed them generally did not tolerate them; and when they were well borne that they were not necessary. The palate may be held forward by tapes or rubber-bands passed through the nose, drawn down behind the palate and out of the mouth, and tied over the upper lip. This method is more commonly used in operating than in examining.

LARYNX.

The lingual tonsil and the glosso-epiglottic fossa are not well seen by using the tongue-depressor, although it is occasionally possible to pull the tongue sufficiently away from the epiglottis to get a view of part of the region. But we succeed so much better with the laryngoscopic mirror that this examination is generally combined with that of the larynx. The forefinger passed all around the base of the tongue gives a very good idea of the amount of tissue present, its character, whether inflammation or suppuration are present, and can often detect foreign bodies which find here a convenient lodging place.

For looking at the larynx the usual method is to have the patient's head held well back and the extended tongue held between the thumb and forefinger of the examiner. This lifts the whole larynx. Care must be taken not to pull the tongue too hard, especially when it is sore or the teeth sharp and rough. For a mirror we use a glass about an inch in diameter, although if the fauces are small or the tonsils large, and usually in children, we have to choose a smaller size. On the other hand, in adults we can sometimes use one much larger, and with one the size of a silver dollar I have obtained a very satisfactory view. The shank should be quite stiff, and I have been surprised to find so many slender and flexible ones in the market. Those sold in students' sets are often too flimsy for actual use. A stiff, firm handle, shank, and mirror are much more easily borne by the patient. The mirror figured (Fig. 563) is one that I have found excellent.

The glass should be warmed over the lamp and the metal back tested against the ball of the thumb to insure its not being too hot. The handle is then taken between the extended fingers and thumb. The mirror is introduced with the glass side down, above and parallel to the dorsum of the tongue, but without touching the latter. The patient is directed to say "*Ah!*" and as he does so the base of the tongue is lowered and the soft palate is raised. The mirror is placed under the uvula, which it carries backward and upward, and the glass is pointed downward at an angle of about 45°. This is the position for looking into the larynx; but it is well before this to look at the base of the tongue. For this purpose we hold the mirror nearly horizontal and near the posterior edge of the hard palate. We can thus look directly down on the base of the tongue, or if we carry the mirror back to the uvula we must slant it farther forward than as if to look into the larynx. We should note the region of the circumvallate papillæ and the glosso-epiglottic fossa, which should normally be free and rather smooth. If hypertrophy of the lingual tonsil is present, we see red, rounded, raised masses filling the whole or a part of the space or even crowding upon the epiglottis, or we may find it acutely swollen, with yellow or white spots on the surface, or false membrane or ulceration. A smooth atrophy in this region is thought by some to be characteristic of syphilis.

Coursing over the base of the tongue in adults we may see large, dilated, or varicose vessels, looking not unlike rivers in the atlas.

After having examined the region anterior to the epiglottis, we place our mirror to look into the larynx, as spoken of above. The epiglottis is now

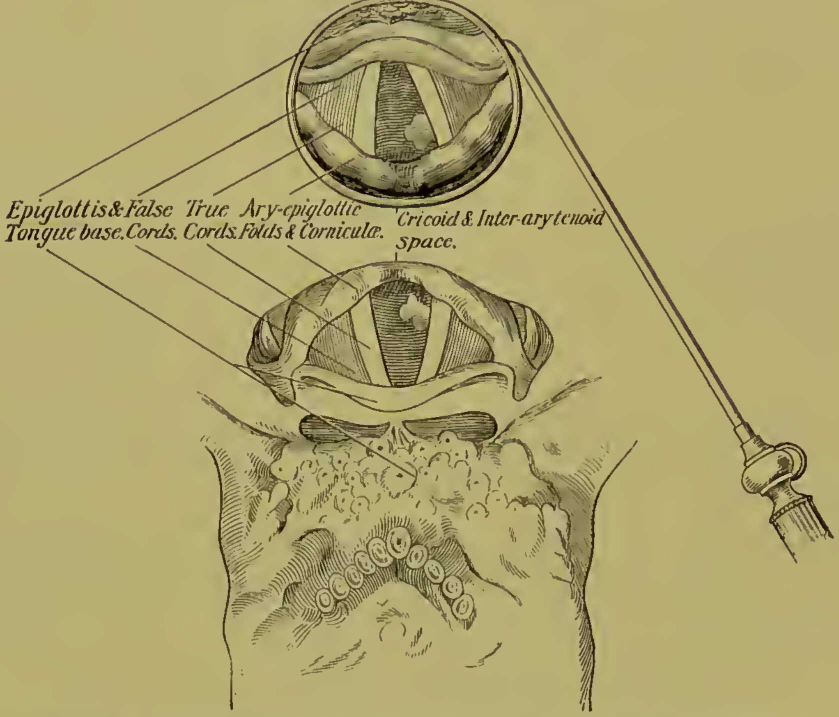
Epiglottis & Tongue base.
False Cords.
True Cords.
Ary-epiglottic Folds & Corniculæ.
Cricoid & Inter-arytenoid space.

FIG. 563.—Schematic view of tongue-base, epiglottis, arytenoids, and ary-epiglottic folds, ventricular bands and vocal cords, with the laryngoscopic reflection. A polyp shows below the left cord (after Schrötter).

the great obstacle and the patient should be told to say "*Ah!*" or what is still better, to take a number of deep breaths and say "*eh!*" during the inspiration. This serves to lift the epiglottis. If not successful at first, we are generally rewarded after a number of trials by seeing it gradually lift. We may at need spray a little cocain into the larynx or paint the posterior surface of the epiglottis and hook it forward with a bent probe, the patient holding the tongue.

The epiglottis varies greatly in shape and position. It is usually of a reddish-yellow color, and its free edge is thin. It may be erect or pendulous, hanging completely over the larynx, or in any position between these extremes. In children it is generally bent more backward than in adults. It may be rounded, incurved in the center of its free edge, omega-shaped, its edge turned over, etc. It is sometimes not symmetrical, and may not be in the median line. The mucous membrane is much more closely adherent to the posterior surface than to the anterior, so that swellings, edema, or cysts are more often found on the latter. Low down on the posterior surface we see the projection called the cushion (see Fig. 541), which is at times quite marked. Extending downward from either side of the epiglottis toward the median line and the posterior part of the larynx we see what are called the ary-epiglottic folds, which are narrow near the epiglottis and become wider as they descend. The two rounded projections on either side of the median line are the small cartilages of Santorini and Wrisberg, and below them are the arytenoid cartilages, whose form is not definitely seen. These structures are covered with a reddish membrane in health. Between the arytenoids is the interarytenoid space, where hypertrophies of various kinds are likely to occur.

The vocal cords are the pearly-white bands which stretch across from their anterior commissure at the inner angle of the thyroid cartilage to the vocal processes of the arytenoids posteriorly. In respiration the posterior ends separate, leaving a V-shaped aperture, but in phonation they lie parallel to and nearly or quite in contact with each other. Just above the cords is a dark space, the opening of the ventricle, more plainly seen when the larynx is thin and relaxed. Just above and outside the mouths of ventricles are the ventricular bands or false cords, which are of a red color.

Below the true cords we see a little of the inner side of the cricoid cartilage, and farther down a number of transverse white bands, the rings of the trachea, and consequently the anterior wall; and occasionally we can even see the bifurcation of the trachea and the opening of the bronchi. Outside of the ary-epiglottic folds are the pyriform sinuses; and the cornua of the thyroid cartilage may sometimes be seen as whitish elevations in their floor.

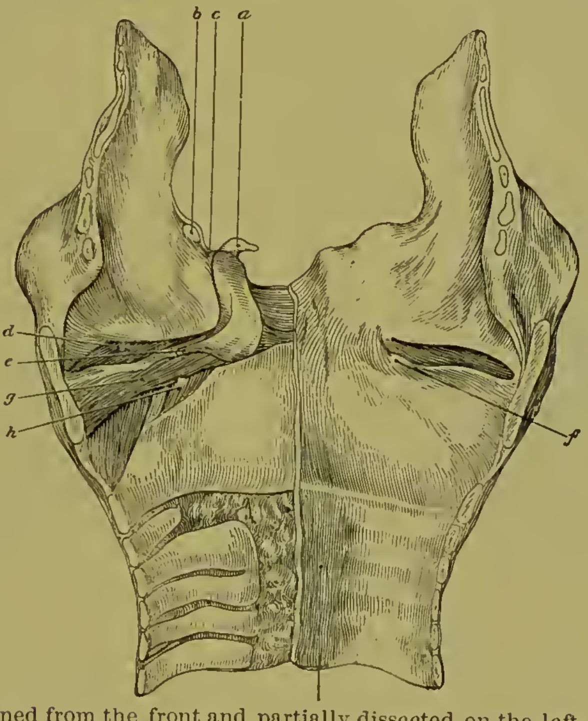

FIG. 564.—Larynx opened from the front and partially dissected on the left showing the anatomical relations of the cords, *e*, *f*, ventricles, *d*, corniculæ *a*, and epiglottis (Schrötter).

In the mirror these laryngeal structures look as if spread out in one plane; but study of the exsected larynx (Fig. 564) shows very forcibly what should be borne in mind while using the mirror—that they are on very different planes, and that from the top of the middle of the ary-epiglottic fold down to the top of the vocal cord is about an inch. It is of great service to study a model or a larynx removed from the body as a preliminary to using the mirror.

The objects looked at in the mirror are seen as if inverted; that is, the anterior commissure of the cords is at the top of the mirror and apparently points backward, whereas the arytenoids are on the lower side of the mirror and seem to be anterior. The figure (Fig. 563) will illustrate my meaning. In using the probe to touch the different parts of the larynx it is necessary to bear this inversion in mind, and it is well to practise on a model. It has seemed to me that students have more difficulty in passing the probe backward against the anterior face of the interarytenoid space than forward toward the anterior commissure when trying on the exsected larynx.

There are many difficulties in the way of obtaining a good view of the larynx. A short, thick tongue, perhaps even tongue-tied, may be almost impossible to hold with the fingers or may fill up so much of the mouth as to leave very little room for the mirror and the light. We may then find it better to use the tongue-depressor and draw the tongue forward with it so as to make room at its base for the mirror. If the throat is very irritable we can spray cocain into the larynx or paint the pharynx or use pieces of ice.

In children the epiglottis is often bent over the larynx in respiration, and the glottis is difficult to see. To overcome this the long, curved tongue-depressor of Mount Bleyer can be used, which goes behind the tip of the epiglottis, lifts it and also the whole larynx to some extent, or the tongue-depressor of Escat may be tried. Its branched ends are placed behind the sides of the epiglottis in the pyriform fossa, and so pull forward and upward the epiglottis as to open up the entrance to the larynx, and a view can be obtained with the mirror. A mouth-gag may be necessary.

In the ordinary examination with the head thrown well back the face of the mirror is so turned as to show the anterior wall of the trachea. If the head is bent well forward while the patient is standing and the examiner, kneeling in front of the patient, holds the mirror well up against the uvula, a very different view is obtained. Instead of the anterior part of the larynx and trachea we see the posterior wall, sometimes even as far as the bifurcation. This is the method of Killian, and is valuable for looking at the posterior part of the larynx, the posterior ends of the cords and underneath their surface. It is not always easy to carry out, as the position of the examiner is not a comfortable one. The saliva runs out of the mouth into the doctor's hand and up his sleeve, so that it is well to have the patient expectorate before we use the mirror. The light does not come in a suitable direction, and the head-mirror is usually beyond its focal distance from the throat-mirror. If the examiner wears glasses they may also be an obstacle from the unusual position of the head. But in spite of these difficulties the view of the posterior part of the larynx and trachea is often very striking and gives information not to be obtained by the ordinary method.

The larynx can also be viewed by transillumination in a dark room. The electric lamp, such as is used for the frontal sinus, is placed against the front of the neck in the neighborhood of the cricoid cartilage. The tongue is held and the mirror passed as in ordinary examinations, only no light is thrown in through the mouth. The larynx is seen in the mirror to be illuminated by a light which traverses the tissues of the neck and gives a yellowish-red look to the parts quite different from the usual examination. It was hoped that this method would be of great service in determining abnormal densities of the different tissues traversed by the rays of light, but it is not much used for that purpose at present.

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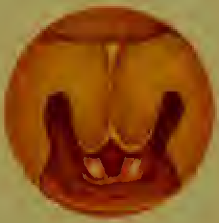
PLATE 13.

1.



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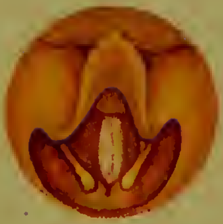

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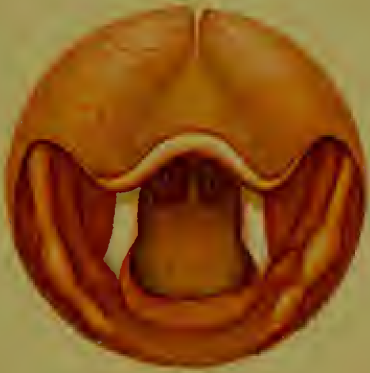

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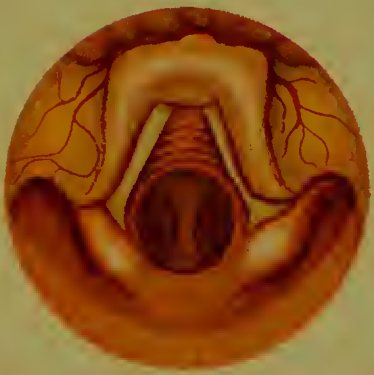

FIG. 1.—Larynx of a child in quiet breathing, nearly covered by the epiglottis.

FIG. 2.—The same during phonation, with the epiglottis raised and the cords in apposition.

FIG. 3.—Adult larynx and trachea to the bifurcation in deep inspiration, showing the back wall by Killian's method, with the chin low and the head inclined forward.

FIG. 4.—Usual view of the normal larynx and front wall of the trachea to the bifurcation (from Krieg's Atlas, with slight modification).

AUTOSCOPY.

Under this name Kirstein has reverted to the oldest method of examining the larynx. No throat-mirror is used, but the base of the tongue and the epiglottis are drawn very much forward by a specially-constructed tongue-depressor, and the examiner looks directly down into the throat illuminated by an electric lamp or by light reflected from a head-mirror and sees the posterior part of the larynx, the arytenoids, perhaps the posterior half of the cords, and the posterior part of the trachea. The patient should have a yielding tongue and neck to give good results. He should be seated, the upper part of the body thrown forward and the head tilted slightly backward. The physician stands in front, and places the depressor as far back as possible on the tongue with firm pressure downward and forward on its root, whereby a deep groove is formed, allowing the rays of light to fall in line with the laryngo-tracheal axis.

According to Kirstein, in about one-fourth of all adults the whole larynx and trachea can be thus conveniently examined, except that the extreme apex of the anterior commissure can be seen in but one-tenth of all cases. About one-half of all people can be fairly well examined, so that the posterior region of the larynx, including sometimes a more or less extensive portion of the trachea, is exposed to view. This method, he claims, is applicable to children under anesthesia, and sometimes without anesthesia. This needs corroboration, and the method is in no sense a substitute for ordinary examination with the mirror, which gives us in most cases all needed information.

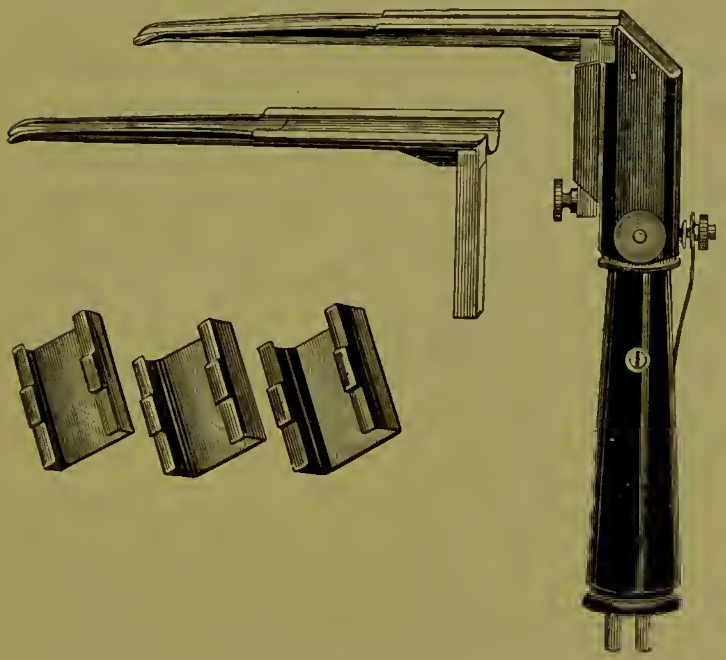

FIG. 565.—Kirstein's laryngoscope with electric light attachment and interchangeable depressor (Thorner).

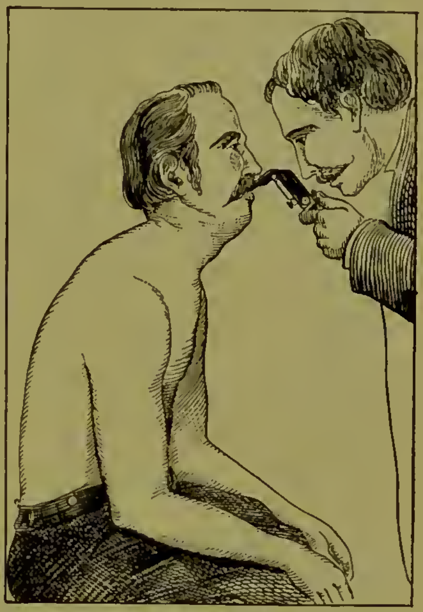

FIG. 566.—Position of neck and head during examination with the electric autoscope (Thorner).

THE RÖNTGEN RAYS.

The X-ray has served to locate foreign bodies in the air-passages and esophagus. The nose and upper throat are so accessible by our present means of illumination that it is not of the same help to the laryngologist as to the general surgeon.

THERAPEUSIS AND PROGNOSIS.

BY GEO. A. LELAND, A.M., M.D.,

OF BOSTON, MASS.

General Therapeusis.—Treatment in the diseases of the upper air-passages may be divided into general and local, the former of which may first be considered. And it may be premised that these regions are not to be considered as separate from the rest of the body, but as a part of it, and not only influencing it but being influenced by it—the corollary of which is that they are not always to be subjected to local treatment alone, but that the general diseases and conditions of the body are to be taken into account. For it will frequently be found that general treatment is far more efficacious in the removal of some of the manifestations of disease in the upper air-passages than local treatment, which is so often, in these days of enthusiastic specialism, given the most prominent, if not the only, place in the thoughts of some so-called laryngologists. An early recognition of these conditions may often save the patient from much discomfort and expense, and the physician from no little anxiety and apprehension. For many local manifestations of general disease are only aggravated by local treatment—*e. g.*, an acute gouty pharyngitis, late syphilitic tumefactions of the tonsils, the first swelling of late syphilis in the nose, the laryngeal papillomata which precede malignant disease, and so on.

Aside from the exanthemata (including typhoid fever) with their characteristic throat manifestations, which will doubtless be discussed in their proper articles, there are some common, every-day conditions which cause much discomfort and no little alarm. One of the most common of these is rheumatism, where there is very little to be seen. The faucial and pharyngeal mucosa shows but slight redness, often in small areas, variable in their locations, more or less early in the day. The history, not only of the individual, but of the family near and remote, assists in the diagnosis. The lithemic diathesis perhaps shows frequent manifestations not only in him, but in various members of his family, even in several generations. In such a throat it is not rational to suppose that the local exhibition of the usual sprays or pigments will produce more than a very transient amelioration, and may, especially the latter, produce only discomfort; this, however, may yet serve a purpose by making the throat seem so much worse that when the irritation subsides the patient considers himself better. It is here that general remedies directed to the diathesis are to be employed. The correction of ailments of the *prima via*, such as gastro-intestinal catarrh, and regulation of the bowels; the exhibition of the lithic solvents, such as the various salts of potash and lithia, the salicylates and salicylic acid (always, however, using these last either not at all or with great caution where there is a tendency to deafness from middle-ear or labyrinthine lesions), piperazin, etc.; the regulation of diet, especially as to the ingestion of foods containing uric acid, and the xanthin group, notably red meats and tea and coffee according to Haig,[1] urging the importance of drinking large quantities of pure water (the English rule being 3 to 5 pints daily)—these among other measures may be mentioned. The solvent action of some of the alkaline tablets, dissolved slowly in the mouth and followed by a copious draught of water, is often of local service, notably those prepared from the Ems Springs by evaporation, and known as the Ems pastilles.

It is notable that in his discussion of general therapy for disease of the upper air-passages, Dr. Phillip Schech devotes a page and a half to the mention and recommendation of mineral waters.[2]

A peculiar manifestation of the lithemic diathesis, and a very distressing one, is the dry mouth and throat rarely complained of by the aged. The salivary and mucous secretions are nearly if not quite absent; the tongue is dry and parched and at times painfully cracked; deglutition is almost impossible. The urine will show almost no color, very light specific gravity, and very small amounts of uric acid and especially of urea. Here some of the measures above noted, assisted at the onset and perhaps longer by minute doses of pilocarpin muriate or nitrate, will produce wonderfully satisfactory results, while the whole gamut of local applications may be tried in vain.

Another form, perhaps, of lithemic diathesis, or at any rate of mal-assimilation, is the thick throat associated with obesity. The faucial appearances here are those of a very narrow space behind the velum, the surface of which is thrown into rugæ by gagging and phonation, thus almost entirely closing the passage. This thickening can most probably not be gotten rid of by local applications without danger of producing too great reaction, and later even cicatrices, which may leave the throat in a worse condition than before. Treatment should be directed to the general condition; to the digestion, both gastric and intestinal; to the action of the liver and the kidneys. And it is possible that we may hope from the study of glandular therapy to find that some of these cases are due to a greater or less degree of Basedow's disease, as was well shown in the report of a case of "myxedema of the throat" by Dr. Farlow, in the last "Transactions of the American Laryngological Association."

In the writer's experience some cases of submucous thickening of the throat have apparently been much benefitted by the exhibition of thyroid extract. Of course, in cases of thickened hypertrophic pharyngitis a local cause may be found in improper nasal respiration, which, as will be referred to in its proper place, can be corrected.

Closely allied with these rheumatic diatheses is the gouty; and it will be found of great value to recognize its acute or chronic manifestations. In its acute form we find a crimson-red, thick, shiny mucous membrane of the pharynx and fauces, where the characteristic feature is the extremely acute pain, much aggravated by swallowing, which seems much more than the manifestations call for. It would be hopeless to use sprays except for slight and transient benefit, and the usual pigments would only produce extreme discomfort for a longer or shorter time. It will be found in the history of such a patient that he has perhaps had some gout before in other and more usual locations, and that he has remedies which he is accustomed to use; and these will doubtless produce a much more satisfactory cure of his throat than other means. And so also in the chronic gouty throat or in the throat convalescing from the acute stage, which has lost its shiny reddened appearance and has become flabby and pale with a muco-purulent, viscid, sticky secretion, remedies directed to the diathesis are much more efficacious than those for local application, except so far as they are beneficial as cleansing agents. In all these conditions allied to the lithemic diathesis it is necessary to pay a great deal of attention to the diet; and here a general physician who has a thorough mastery of the physiology and pathology of digestion, or the throat specialist who adds this also to his specialty, will have greater success than he who simply treats locally.

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[1] *Uric Acid in the Causation of Disease*, A. Haig, 1896.

[2] *Die Krankheiten des Kehlkopfes und der Luftröhre*, 1897, pp. 50 and 51.

There is another condition described as neuralgia of the throat where there is a great complaint of painful sensations both at rest and upon movement, especially probably in the latter part of the day, and the pain is of a sharp and lancinating quality; here local applications are absolutely contraindicated, since they generally produce an aggravation of the discomfort. It will be found that the patient is anemic or neurasthenic and that general treatment is much more serviceable than local. Here, however, it may be said as applying to this condition, as well as to those which have been before mentioned, that where the symptoms are especially referred to any one part, the patient feels much better to be doing something; and while not much is to be expected from local treatment *per se*, some simple gargle may be prescribed as a placebo.

Another painful condition of the throat is to be found in hardworked individuals, especially professional men. It is not infrequent that overworked physicians, clergymen, teachers, and even lawyers have a painful condition of the throat come on at the end of the day: this is simply a condition of muscular and nervous fatigue, in which local applications are of little benefit, but where rest, and tonics like nux vomica, are very efficacious. It is not infrequent to have an overworked physician drop into the office late in the day complaining of just this fatigue of the throat, and it is with great satisfaction that we can assure him that there is no alarming malady threatening. Public speakers doubtless have this trouble much aggravated by an improper use of the voice, and the so-called "ministers' sore-throat" is often but the result of the American method of talking back in the throat with indistinct articulation—swallowing of the words, as the Germans call it. Correction of bad habits, with attention to the general condition of the patient, will here give the best results. Some of the lozenges may be of assistance to reduce hyperemia or to induce moisture when there is a sense of dryness, but they are merely palliative; the underlying cause must be sought out and abolished.

In this place may be mentioned a peculiar condition of the pharyngeal mucosa characterized by thickening, pale pinkish color, sluggish scanty secretion, and obstinacy under treatment, which, on the exhibition of iodids and perhaps mercurials, will seem to be due to a latent taint of specific disease, although the history is doubtful or absolutely negative and there are no other lesions to be discovered in ordinary examination. This is not very common, but should always be borne in mind; and it will be found that this treatment does not always have to be used as a *last* resort. The pathology of this condition has probably not been throughly worked up; but it may be said in general, judging from clinical observation, to be a submucous infiltration with more or less involvement of the superficial lymphatic structures which have a rather pale and asthenic appearance. These may easily break down in a superficial loss of substance with a grayish base; not the usual appearance of a mucous patch, but more nearly that of a superficial abrasion from rough treatment, a scraping off of the surface, as it were. It may not be true that

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these appearances are always due to specific disease; but it has happened to the writer to have them clear up so kindly under the iodid of potash or syrup of hydriodic acid, perhaps assisted by biniodid of mercury, and afterward to find an obscure history of infection, that it does not seem to be a condition of great rarity. Of course, where there are the characteristic lesions of secondary or later stages, the ordinary remedies, both general and local, will be exhibited without question.

There is one other condition which seems to claim a place here, and that is an affection of the throat where there is an even blush diffused over the fauces and pharynx and even the mouth, of more or less intense redness; sometimes the tongue will be fiery red, with none of the usual coating, an appearance which is shared by the interior of the mouth and throat to a less degree. Arsenical poisoning must here be borne in mind, especially if it is found that the patient is better away from his ordinary dwelling, as in vacation time, or that he has the usually ravenous appetite, with perhaps the malaise of this condition. Perhaps he is given to the deleterious habit of putting things into the mouth, as in one case which came under the writer's observation, where in reading a book the patient tore off the corner of each page after finishing it and put it into his mouth. With this throat it is well to institute the usual investigation to find out the source of the poison, including the examination of the urine, to see if it is present in the system, or to clear up at least that possibility. General treatment only can here be indicated.

The various forms of paralysis come under this general head, among which may be mentioned paresis of the palate in greater or less degree in post-diphtheritic paralysis, or in the early stages of tabes dorsalis; the laryngeal crises in later stages of this last distressing disease; or vagus paralysis on one side in aneurysm of the arch, or of the innominate, or from pressure of mediastinal glands, etc.

There are doubtless other states of the system which have their manifestations prominently in the throat, but those mentioned are the most prominent which have come under the writer's observation. Figures are not at hand and probably have not been collected to enable us to judge of the proportion of such cases; but it is doubtless true that a very large percentage are much better treated by general measures than by local treatment alone, and it is also obvious that general treatment is only assisted by the local in their management.

Before leaving the general part of the subject, it may be well in this place to note certain hygienic measures which may offer suggestions in preventive therapeutics or preventive medicine, in which such vast strides have been made toward the comfort of humanity in our modern times. An ounce of prophylaxis may be worth a pound of surgical or pharmaceutical interference.

In general, it may be asserted that nothing is more conducive to the maintenance of a proper condition of the mucous membranes of the upper air-passages than the avoidance of colds; for to colds may be attributed the beginning of most of the common inflammatory states of these membranes. Their initial congestions are due principally to three causes: 1, a sluggish skin; 2, a state of the blood best called lithemia in our present knowledge of the subject; and 3, to the action of atmospheric micro-organisms and dust.

1. If the skin is active—*i. e.*, if, after being chilled, it will again take up its quantum of blood on returning to warm surroundings—the internal con-

gestion, called cold, will not remain. To keep the skin active is one of the problems in the prophylaxis of catarrh. This raises the question of clothing, bathing, ventilation, and heating.

The clothing should be adapted to the weather; and in a changeable climate like that of New England and the Atlantic coast, also of the Southern shore of the Great Lakes, should be of such material that sudden chills may be avoided. The layer next the skin should be such that it will conduct the perspiration, both sensible and insensible, into the next layer, so that the skin may not be in a damp envelope. To this end cotton should be avoided because it does not hold the body-heat if dry, and when wet with perspiration allows rapid evaporation and so chilling of the surface. Wool is almost universally recommended because it retains heat: it is, however, irritating to sensitive skins, and, having the property of absorbing moisture slowly, also gives it off slowly. Hence the skin is damp before the moisture is absorbed and enclosed in a damp envelope afterward, which may keep up evaporation and abstraction of body-heat for a long time, until the garment has become dry again. This would be an advantage to the laboring man who is constantly manufacturing heat; but is a disadvantage to those who have long periods of rest between those of exercise. The material, however, which seems theoretically to answer the purpose best is a new one now bidding for public favor, viz., a linen mesh. This is smooth, unirritating and absorbent; it carries the moisture from the skin, and quickly drying, maintains a layer of warm air next the surface of the body. It remains to be seen whether its advantages will enable it to win recognition against the popular prejudice in favor of wool.

In general it may be said that clothing for the house should not be too heavy, but that sufficient addition should be made on going out in wintry weather. The fashion of wearing furs, except in the most rigorous weather, is doubtless conducive to dampness of the skin and should be avoided. Woollen outer garments are much more to be recommended than the heavy impervious pelts through which there can be no ventilation; like the rubber boot, the latter tend to keep the skin in a bath of perspiration, which is destructive of its activity and allows the rapid loss of heat on their removal.

Bathing, both for its stimulating and cleansing purposes, is rightly considered not only a prophylactic but a therapeutic measure of great service in the treatment of catarrh of the upper air-passages. Rosenberg[1] recommends daily cool baths, and it is well known that they who take the cool morning dip are less troubled with colds; doubtless because the vaso-motor system is toned up to better control of the vascular supply of the nose.

Little need be said on this subject except to caution that the skin should never be left in a slightly moist state after a bath. Hence, the cold or hot bath is much better than the tepid one which is not stimulating enough to produce a reaction. As a therapeutic measure the very hot bath (103° to 108° F.), used within the first forty-eight hours of a cold, followed by a cold dash (60° to 80° F.), and this followed by vigorous friction till the skin is perfectly dry and of a pink color, is one of the best means which can be suggested to break up a cold. The hot soak should be continued fifteen to twenty minutes; the cooling off from two to ten minutes; and after the drying of the skin the bed-clothing should not be heavier than usual.

In this connection may be mentioned that *hyperidrosis pedis* with its accompanying cold feet is a prolific cause of catarrh, not only of the hypertrophic, but of the atrophic variety—as mentioned by Kretschmann, quoted by Jacobson.[1] This author recommends very stimulating treatment for the feet, and states that cure may be brought about even in atrophic rhinitis without local treatment.

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[1] *Die Krankheiten des Mundhöhle, des Rachens, und des Kehlkopfes,* Berlin, 1893, p. 84.

The necessity, therefore, of keeping the feet warm and dry is obvious. Foot-wear in cases of catarrh should be as carefully attended to as possible: in the damp winter and spring weather the ordinary leather sole, especially of ladies' shoes, is probably never thick enough to keep dampness from the sole of the foot, and should always be supplemented by rubber.

Shampooing the head is also sometimes a cause of obstinate inflammatory conditions, most often, perhaps, because of insufficient drying, which allows of chilling of the surface by evaporation and hence congesting of the interior. This may take place even in some cases where drying is properly done. It is a question whether the long hair of our lady patients can be dried so as not to work evil in some catarrhal cases. At all events, the evil is sufficient to make the practice always a subject of inquiry.

Ventilation.—This is a matter of no small importance, especially as regards that of the chamber at night in the winter season. The popular craze for fresh air during sleep is often carried too far. To live in a room artificially heated to 70° to 80° F. during the day, and then to retire with the windows open, so as to be practically out of doors with uncovered head when the body-resistance is reduced in sleep, would seem to be wholly irrational. The sunless, chill night-air, blowing in steady draughts or only in gentle gusts upon the unprotected head, must do much injury in catarrhal cases, and should be strenuously avoided. The night-caps of our grandparents, relegated to the past with their unheated chambers situated remote from the warm living-rooms, would still be useful articles of night-clothing for those who must sleep with open windows.

Heating.—In our northern climates this should receive careful attention from the throat specialist. The physiological functions of the nose in respect of the supplying of moisture to the inspired air should point out to us the cause of much of the engorgement and hypertrophy of the interior of the nose and throat which manifest themselves in winter colds. The air below the freezing-point is deprived of much of its moisture: brought into our houses and raised to 70° or 80° F., or drawn in as breath and raised to 98° F., it must take up its quota of moisture. Hence, a more or less increased function of the mucous coverings of the turbinals—and in mouth-breathers, of the throat—which results in an obstructive engorgement or in chronic inflammatory thickening. These evils may be avoided by proper saturation of the indoor atmosphere with moisture—much more important when the heating is by steam or hot water. It is obvious then that cauterization of such engorged noses may be productive of evil, and painting of such hyperemic throats with astringents only a source of discomfort and not of cure; and that both may be more rationally treated by proper attention to indoor atmospheric conditions. Here the hygrometer comes to be a much more important instrument of observation than the thermometer. And it may be said that houses are much more comfortably heated when this instrument registers 65° to 80° than when below 50° F.

2. **State of the Blood.**—It often happens that patients complain of colds which they say come on without cause—*i. e.*, without known exposure or carelessness in dress, etc. This may often be due to a lithemic condition, as lately pointed out by Dr. L. Duncan Buckley. A cold may thus be, as

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[1] *Lehrbuch der Ohrenheilkunde*, 1893, p. 435.

it were, a uric-acid explosion. On investigation it may be found to follow the ingestion of a heavy meal, or of a quantity of malt liquors, or of tea or coffee—which Haig[1] has shown to contain large quantities of the xanthin group—or to neglect of proper exercise or bathing.

Buckley's method of cure has been found in certain cases to be very efficacious, and is as follows: Twenty grains of bicarbonate of soda are given every one-quarter hour for four doses; if there is not sufficient relief after waiting two hours, the same series is repeated. The five-grain soda-mint tablets are a convenient means of administration.

3. **Atmospheric Micro-organisms and Dust.**—Probably the presence of colds in a large part of the community at any one time, so as to seem like an epidemic, is due to this cause. The prevalence of epidemics of influenza, of hay-fever, of diphtheria, or tonsillitis is often accompanied by great frequency of colds, or at least of irritable states of the upper mucous membranes. At other times, when the graver forms are not so pronounced as to show evidence of the above-named diseases, colds may be the lesser expression of their influence.

The mechanically and chemically irritant effects of atmospheric dust are a prolific cause of inflamed mucous membranes. Hence during the windy months in our cities it is often almost universal to see cases of inflamed noses and throats due solely to surface irritation. Certain classes of the community also are frequent sufferers from this state of the mucous lining of their upper air-passages—among which may be mentioned gentlemen who assume personal care of their furnaces, teachers who make much use of the blackboard, workers in dusty shops, and tinsmiths and plumbers who inhale the acid fumes inseparable from soldering. For these people some of the various nasal respirators are of service to clear the inhaled air (or even a small tuft of absorbent cotton introduced into the orifice of each nostril), and bland or protective sprays may be frequently used with advantage to cleanse the irritated surface. Schech and others recommend that sufferers from bacteria-laden or dust-laden atmospheres in larynx or nose be removed from the city into the cleaner air of the country or the woods.

Mouth-breathing.—This is a habit which should be interdicted *in toto* from the very earliest moment of life; and it is the duty of every physician to impress upon the young (or old) mother that nasal respiration must be insisted upon at the outset with every infant. The parts are so small that if the nose is deprived of its proper air-currents, the engorgement of the parts soon closes it. The accoucheur attends to the funis, the bowels, and even the eyes of the infant, but habitually omits to call attention to the importance of nasal respiration. It is not improbable that this may be one factor in the early occurrence of obstructive nasal engorgement which results in adenoid vegetations.

Diet.—This must usually be left to the family physician; but at times even the throat specialist may find it convenient to interfere. When the trouble is due to the lithemic state and its congeners, as mentioned above, it may be necessary to proscribe sweets and starches in some cases, or nitrogenous foods in others: highly spiced foods may keep up a congestion of the fauces and pharynx. Alcoholic beverages probably act in two ways, as local irritants and as vaso-motor dilators. To avoid the first effect, the stronger liquors should be diluted; to obviate the second, excessive use should be prohibited. In the writer's experience the most uniformly reddened and thickened mucous membranes of all visible parts of the upper air-tract above the bifurcation of the trachea was in a man who complained not of pain but only of some discomfort, who confessed to habitually having taken about fifty drinks of whiskey *per diem* for several years; miscellaneous libations of the vinous and malt liquors were not counted.

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[1] *Loc. cit.*

Tobacco undoubtedly exercises more or less of an irritating effect on the mucous membranes, especially when, as Rosenberg[1] even finds it well to say, the smoke is blown through the nose. The inhalation of cigarettes probably is the worst form of the use of tobacco; but there is a vast difference in the irritating effect of tobaccos. Those which contain saltpeter in appreciable amounts, whether natural to the leaf or introduced in the curing, should be avoided by patients whose throats are irritable, or by those whose tongues or lips show a tendency to leukoplakia. The presence of the nitrate of potash is easily seen when the fire causes a flashing as it progresses down the leaf and leaves minute white dots of the hydrated carbonate of potash on the ash. This drug is probably introduced to carry the fire in moist tobaccos—such as plug and cigarettes, as well as in some cigars designed to be used "green," and is chosen because it has no objectionable flavor, but only adds a pungency to the smoke. But in the decomposition by combustion, nitric acid is given off to be added to the smoke, which can but be irritating to the mucous surfaces with which it comes in contact.

Rest.—Schech lays great stress on the importance of rest in inflammatory and ulcerative conditions, especially when, in the vocation of the patient, use of the voice is necessary. He even goes so far as to send the patient away to a quiet place or resort, according to the severity of his condition.

Use of the voice should be interdicted in inflammatory states of pharynx and fauces, and especially of the larynx; and in the former the use of some drug, as belladonna or atropia, to diminish the secretion and so diminish the necessity of swallowing, may be of service. In cases of singers' nodes (pachydermia tuberosa), both acute and chronic, absolute rest of the voice is the most efficient method of treatment, and should be insisted upon also with any other mode. *Per contra,* in paralytic affections, especially those depending on the hysteric or neurotic state, diphtheritic paralysis, etc., exercise should be employed rather than rest—according to the same author.[1]

After this somewhat lengthy but, it is to be hoped, useful consideration of the general therapeutics and hygiene of the subject, we come to that of the local manipulative treatment, which too often assumes a greater importance than it really deserves. And at the outset it is well to lay down a principle that whatever is to be done should be done with strict attention to the physiological function of the parts—that their efficiency should be by no means impaired, but facilitated.

Local Treatment.—In local treatment there are employed various means and procedures, as follows:

Gargles.—It is a universal custom to prescribe gargles for almost every affection of the throat, but it is obvious that in laryngeal and naso-pharyngeal affections they are, as a rule, wholly useless unless a method is employed which requires a great deal of practice for its proper performance. It is possible by half swallowing the fluid to reach the top of the larynx, and by suddenly throwing the head forward in its ejection to wash the naso-pharynx, as elucidated by Swain and others; but in the most common use of the gargle it probably does not reach back of the posterior pillars of the fauces. "Made-up" gargles have deservedly fallen into disrepute, and, although tannin and some other astringents are sometimes used in acute congestions, they are of doubtful value. Astringent and stimulating remedies must necessarily be irritating, and, therefore, in painful and inflammatory states are apt to aggravate rather than cure.

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[1] *Loc. cit.*

Gargles are of more value, probably, because of their temperature than of their composition. The most useful gargle is, in the writer's opinion, hot water, to which may be added simple substances such as bicarbonate of soda or borax, or even salt, which have cleansing and stimulating or soothing properties and are easy of access. In the inflammatory states the extremes of heat and cold are of greatest value, and in such affections as acute inflammation of the fauces or tonsils, probably extreme heat as a gargle, or better, as advocated by Smith of Cleveland, pressed upon the inflamed area in the form of a large tampon soaked in hot water, has much antiphlogistic power. The universal use of chlorate of potash as a gargle is probably of most value as a placebo.

Sprays.—The forcible and voluminous spray recommended by Mackenzie is doubtless of great value as a cleansing agent and should be used warm in the nose: the solution should be of the strength of two-thirds of one per cent. of alkali (as Dobell's or Seiler's solution) to give a bland, unirritating wash for the nasal mucous membranes. It should be a rule that no liquids which cause smarting should be used in the nose; and that liquids should be used principally when there is secretion to be washed away. The nose is made for air and not for water; and it is probable that much evil is produced by the routine employment of sprays and washes on the Schneiderian membrane. In inflammatory states soothing sprays may be used, such as those exhibited in an oily menstruum; but even these are suspected of doing evil after long-continued use, since they tend to cause a feeling of dryness and discomfort, probably affecting the secreting power of the mucous membrane unfavorably. In sluggish states of the secretion, or in atrophic states, stimulating sprays may be employed, such as those containing iodin or alcohol in various proportions. Rectified spirit is used by Miller of Edinburgh in cases of polypi, and by Creswell Baber in hypertrophic rhinitis (McBride).[1]

Cold sprays should not be used, lest by producing a hyperemia they may produce a chronic engorgement. The spray-apparatus most highly to be recommended is that which has a nasal tip in the shape of an acorn or cone, which should be introduced only into the orifice of the naris, pointing backward parallel with the septum, the fluid being propelled by a force of not more than ten to fifteen pounds pressure, lest the mucosa of the turbinates and septum be abraded. The straight-pointed tips often sold for nasal use are to be avoided, except in the hand of the physician, since the tender mucous surface of the septum anteriorly near the columna may be so wounded by contact that an eroding ulcer may be started and kept up. It is not infrequent to see an area a centimeter in diameter, with a crust more or less bloody, under which is an ulcer of the septum which will produce a perforation if allowed to continue. This may also be brought about by improper use of the handkerchief or finger-nail, as well as by the end of the spray-tube; hence, the acorn- or cone-shaped tip is the one which should be used by the patient himself in his own nostril, the shaft being held parallel to the median line.

An atomizer which .forces considerable fluid should be selected, since the use of the finest sprays is usually most inefficacious and tedious. Sprays may be used with greater force in the fauces; but the turned-up tip for the naso-pharynx is of doubtful value, since its contact with the mucous membrane of the throat may often produce irritation. Sprays used in the larynx for cleansing or soothing purposes are of great value in the hands of the physician, and if used during phonation probably can be made to reach all supraglottic parts of the larynx; and with a forcible stream, perhaps under pressure of twenty pounds or more, with a spray-tube capable of delivering a large volume, the interior of the trachea can sometimes be cleansed, during deep inspiration, of the inspissated secretion of a dry inflammation of its membrane. In the larynx at first but a small amount of the fluid should be sprayed in quickly, lest the patient be embarrassed by unpleasant spasm and cough. Vapors formed by very fine comminution of fluids are of doubtful value in the upper air-passages, since only an exceedingly small amount of the medicament can come into contact with the membranes, especially if coated with secretion; and it is hardly possible that such mild applications can be of much service, since it is the function of mucous membranes to throw off all foreign substances. Thus, in all these uses of sprays it is well to bear in mind that the solution should be of sufficient strength to accomplish its object before the mucous secretion can wash it away, except where cleansing only is desired, when this eliminating property of the membrane is more or less in abeyance.

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[1] *Diseases of Throat, Nose, and Ear*, 1892.

The use of the nascent chlorid-of-ammonium vapor caused by the union of the fumes of strong hydrochloric acid and ammonia water by means of an apparatus devised by Vereker, Lewin, or Kerr is doubtless of considerable value: the way in which it acts is probably not yet determined, but the membranes assume a more normal condition after being well bathed with its white dense cloud.

Douches.—Douches are of great value when properly used, but are liable to be exceedingly dangerous. The introduction of a solid stream of water by whatever means is antagonized perhaps overmuch by aurists, because of the liability to force the fluid into the middle ear. There is no doubt, however, that intelligent patients may be able, under explicit directions and by experience, to so use the douche that it may be of greatest value, especially in cases of atrophic rhinitis or other less offensive purulent conditions. The very hot douche may be of use in its poultice action to reduce inflammations in the nose which cause such inflammatory states of the accessory sinuses, as recommended by Bosworth; but the rule should be laid down that the douche should always be introduced through the narrower nostril and that the act of swallowing should not be performed during the passage of the stream; and after its use that the fluid should be hawked away from the naso-pharynx before blowing the nose; and, of course, that the Politzer air-douche should not be used until a considerable time has elapsed. It is probable, however, that after the membranes have been soaked by the use of the douche, the patient may be more susceptible to cold in going out into the open air in the colder weather. The solutions to be used in the douche are usually those, such as Dobell's and Seiler's, which have alkaline and antiseptic properties. They should be of such strength as not to produce smarting or tingling of the membranes and should be at the body temperature or higher; about two-thirds of one per cent. is the proper strength. The small elevation of the reservoir is important; the bottom of the reservoir should not be over six or eight inches above the orifice of the nose. The patient should also be cautioned never to use the douche carelessly or in haste; for one lapse might destroy the middle ear for life.

The external application of cold and heat is often serviceable in inflammatory states of the nose or of the throat. After injury an extreme cellulitis may be kept under by cold compresses on the nose. Acute tonsillitis may be aborted by holding an ice-bag behind and under the angle of the jaw. Acute laryngitis, even to the extent of inflammatory edema, may also be aborted or kept under by the ice-bag or by Leiter's coil (cold) around the front of the neck. The application of heat to the tonsils and throat, in the form of the poultice or coil, is often very grateful to the patient, and requires no comment.

Powders.—The use of these agents in the nose is not physiological, because of its function to get rid of foreign bodies by sneezing, hypersecretion, and the action of the ciliated epithelia. Hence, the general use of snuffs because they "clear the head" is calculated to entail congestion and hypernutrition, especially in the common form of catarrh of which patients complain, which is generally that of a slight hypertrophy or engorgement; they should be forbidden, since they tend to increase the evil. Bland antiseptic powders, however, can often be used to advantage after operations or in cases where there is superficial loss of substance in the nose, or even where only the cilia seem to be absent. Such substances as iodoform, dermatol, aristol, and their congeners, which have become so numerous of late, may be of value in these cases, either pure or diluted with starch or bismuth or even compound stearate of zinc. It must be borne in mind, however, that, as in the ear, an insoluble powder sometimes hinders the proliferation of the mucous membrane to cover a defect. In these cases, therefore, insoluble powders should not be used; but they should be of such material that by the heat and moisture of the nose they will be melted into an oil or syrup.

The use of powders in the larynx probably does not in most cases compensate for the discomfort which they cause; but the antiseptic powders and those having a specific action, such as iodoform and its congeners, are valuable in ulcerative conditions of this organ.

The best powder-blower for the nose is one manufactured by the Davidson Co., known as No. 192.

Pigments.—The name of these substances is legion—and is continually being added to—but the one substance which has lasted through many periods of antagonism, and which is now probably the most universally used, especially in Germany, is the solution of nitrate of silver in various strengths; this has a slightly astringent, strongly antiseptic, and somewhat stimulating action. It can be applied—except in the nose—to all the parts of the upper mucous membranes. It is best applied to the naso-pharynx and larynx in strength from 2 to 8 per cent.; and may be used even to 12 per cent. in the larynx and on the tonsils. It is best, of course, to begin with mild solutions and work up. It is to be borne in mind that the nitrate of silver sometimes produces ceruleanism; and the writer has seen at least one case where a deep-brown pigmentation of the membranes and a dull coloration of the skin was attributed to the use of nitrate of silver in the throat; fortunately these cases are of extreme rarity.

Where an astringent effect is sought for, as in pharyngitis, solutions of tannin, 60 grs. to the oz. of glycerin; of the subsulphate of iron, 40 grs. to the oz. of water; of sulphate of zinc, 10 to 30 grs. to the oz. of water (also used as a spray), may be mentioned among others as of considerable value. It is probable that the use of astringents in the nose, such as tannin or iron, even in their strong solutions, are productive of more discomfort to the patient than of benefit to his condition; much better results may be obtained by the use of caustics.

As stimulating pigments may be mentioned tincture of iodin from 10 to 50 per cent. in glycerin, which may be of value in various states of the pharynx characterized by sluggish secretion. Some have recommended a saturated solution of iodoform in ether in such conditions. The pigment selected should be applied by a brush; various kinds are recommended, but probably the most efficacious is that made by twisting a pledget of cotton on the roughened end of a metallic applicator. In all manufactured brushes there is the element of uncleanliness, and the shoulder of the part containing the hair is apt to injure the membrane with which it comes in contact. In Germany a form of forceps, such as Baginsky's, is frequently used to hold the saturated pledget of cotton; but they are unwieldy and have no advantages over the cotton firmly wound upon a roughened stilet. One of the great disadvantages of the brush is that the hairs, one or all, may be left in the throat of the patient. This can never occur with a cotton applicator properly made.

Tampons.—In atrophic rhinitis the Gottstein tampon, either dry or saturated with a stimulating solution, has been very much advocated. It produces its effect by extreme irritation, which brings on a hyperemia and, therefore, greater nourishment of the parts. The principle is doubtless correct. The small pledget of cotton or tampon soaked with a 4 to 10 per cent. solution of cocain (to which has been added 4 or 5 grs. of resorcin to the oz.—which not only preserves the fluid but seems to prevent constitutional effects) and accurately applied to the atrophied turbinals is also of great value in these states. The first effect of the cocain is to exsanguinate the parts; the second is to paralyze the vessels and so to induce a passive hyperemia which lasts a considerable length of time and increases the nourishment of the parts without the disagreeable effect of the Gottstein tampon.

Cocain.—To this drug the rhinologist is indebted for the opening of his whole field; but on account of its secondary action and its constitutional effects its use should be restricted to diagnostic purposes. It should not be prescribed for the patient's personal use, and may be said to have no therapeutic value except in cases of atrophic rhinitis, as mentioned above. When, however, in the later stages of tuberculosis, or of malignant disease of the larynx, deglutition becomes excruciatingly painful, it may be used to enable the patient to eat with more comfort and so keep up his nourishment. The formation of the cocain habit, which is doubtless one of the worst of the drug-habits, must always be borne in mind, although fortunately it does not seem to be very common among patients.

In the first congestion of a cold it may be of use to establish nasal respiration; but if the result is not permanent after one or two trials its use should not be continued. It is without doubt true that the continued use of cocain produces a state of engorgement and hypertrophy which is most intractable. The great advantage of cocain in producing anemia and shrinking of the nasal structures—as well as anesthesia—does not seem to be shared by the new drug lately brought to notice, eucain. The fact that the latter produces engorgement and hyperemia will probably prevent its coming into general use in the nose. Menthol has a mildly anesthetic action—*e.g.*, in 5 to 10 per cent. solutions in oily menstrua, and may be useful in some cases of painful deglutition, but cannot take the place of cocain.

Lozenges and Troches.—Certain substances are with advantage put into this form: the drug makes a solution or mixture with the saliva and accomplishes the object desired. For stimulating purposes, when the throat feels rough and uncomfortable, the various combinations of chlorid of ammonium are very useful; among these may be commended those made after the formula of the London Throat Hospital Pharmacopeia, with black-currant paste; and those compounded with cubebs and licorice or with guaiacum, made by various pharmaceutical chemists, may be mentioned. Antisepsis is by this method often carried out most efficiently in cases of foul mouth or lacunar tonsillitis, or even in mild cases of streptococcus or diphtheritic throats by use of tablets of the bichlorid of mercury $\frac{1}{1000}$ to $\frac{1}{200}$ gr., as made by Fraser, Wyeth, and others. Tablets of these strengths are not disagreeable to the taste, and should be dissolved in the mouth every one to four hours, thus converting the saliva into an antiseptic solution of more or less strength. In acute tonsillitis may be recommended here the small tablet, made by Fraser and others, called "tonsillitis tablets," containing aconite and belladonna to influence the circulation, and the red iodid of mercury as an antiseptic; probably this iodid of mercury is more powerfully antiseptic than the bichlorid, and $\frac{1}{100}$ gr. in each tablet is not too much to be given every two to four hours. In mild inflammatory conditions where there is considerable annoying irritation of the fauces, the tablets of "red gum" or other astringent drugs may be used with advantage. After the irritation produced by smoking, chlorid of ammonium and red gum have been often given to advantage.

The almost universal remedy in this form is chlorate of potash, which, given in all states of the throat, is almost as often given erroneously. This drug is supposed to be taken into the circulation and eliminated by the salivary glands and mucous glands of the fauces and pharynx; it therefore increases the activity of the blood-supply of these regions, and hence should not be given in acute inflammatory states. In cases, however, of dry pharyngitis, where there is more or less lack of secretion—the chronic inflammatory thickening producing an engorgement and, therefore, sluggish action—this drug generally finds its rational therapeutic use.

It may here be mentioned that some drugs seem to have a specific action on the membranes of the upper air-passages: for example, the iodids increase their circulation and glandular action; belladonna diminishes their secretion, and may be used when, as in an early coryza, it is desirable to stop the mucous flow. Quinin, arsenic, nux vomica, and other tonics are of value in those cases of engorgement of the nasal mucous membranes where the vaso-motor system seems to have lost its tone. Iodids seem also to increase the secretion of the larynx and trachea, so that they may be given where an expectorant effect is desirable.

Massage is recommended, notably by some German authors. In atrophic rhinitis a stroking or vibratory massage has been recommended (by M. Braum) and much claimed for it; but Rosenberg[1] considers it of doubtful value, although some good effects have been observed. A probe-tipped applicator is wound with cotton which is saturated with a solution of tincture of iodin in glycerin, 1 part to 4 or 8, or in an ointment containing iodin, and applied to the membrane in this manner. The object here is an increased blood-supply, as in the case of the tampon. Laker recommends a similar procedure in dry laryngitis. In paralysis, muscle-weakness, and neuralgia, massage is recommended by M. Schmidt and others.

Electricity is doubtless of greater value in these conditions, either used as the faradic, induced vibratory current, or as the interrupted constant galvanic current. Electricity may be used, by means of the double electrode of v. Ziemssen, on the muscles of the velum palati, fauces, or in the larynx; or more comfortably by the ordinary single electrode, the kathode (N) being placed on the area to be treated, and the anode (P) by a sponge electrode at the outside of the throat or back of the neck. In diphtheritic paralysis, in the weak muscular action of the late persisting puerile voice, in the fatigued larynx of singers, especially after a cold, these procedures are of great value, the strength of the current being regulated by the sensations of the patient. Faradization of the whole larynx may also be accomplished by pressing a small electrode deep at each side of the larynx, or by placing the negative pole in front of it and the positive pole at the back of the neck. This procedure is of much service in atonic states characterized by weak voice, caused by cold, overuse, or vocal strain, and similar conditions.

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[1] *Loc. cit.*, p. 87.

The combination of massage and electricity to the outside of the larynx is often very useful. This is accomplished by clamping the negative pole to the right hand or wrist of the operator, so that the current will flow through the fingers, and placing the positive pole at the back of the neck, as before mentioned.

Caustics.—In the use of these destructive agents the greatest caution is to be advocated, since they are to be used principally in the nose and larynx. It is very easy to remove by their means redundant tissue; it is not so easy to remove just enough and still preserve the functions of the parts. It should be the rule to do a little less than enough rather than a little more, since it is easy to burn more, but not to restore that which has been too zealously destroyed.

In the nose first was used glacial acetic and fuming nitric acids, but being liquid, their action was difficult to control and they have deservedly been relegated to the past. Next comes chromic acid, which could be fused on a metallic applicator and drawn in lines along the turbinal bodies. Its disagreeable odor, its active deliquescence and too powerful action, causing a deep wound and a troublesome slough and slow healing, have been disadvantages which have led to its disuse. It is, however, the best agent to close the little bleeding vessels in the septal ulcers before mentioned, which are the frequent cause of epistaxis.

The best acids for caustic action are without doubt the monochloracetic and the trichloracetic acids. These act practically in the same way to produce condensation (Bosworth) of the tissues subjacent to the area of their application, the former having a little more powerful effect than the latter. These acids come in crystals and can be readily fused on the applicator; or, being slowly deliquescent, the thick liquid can be taken up on a probe very finely wound with cotton (the excess being shaken off), and this will have almost the same caustic value as the former method and is easier of preparation. These acids have the great advantage that the slough becomes hygroscopic and remains on the site of the application as a protective covering, like a piece of wet chamois skin, leaving a smooth surface on removal. After the effect of the cocain has subsided, there is apt to be some pain; but it is not lasting, and is far less than after the use of chromic and glacial acetic acids.

The most efficient and most accurately controllable agent in this class is the galvano-cautery; and now it is the most reliable, since the rheostat has been perfected and the Edison street current can be brought to our hand, enabling us to discard the ever troublesome and expensive battery.

This powerful agent should not be used on turbinals presenting a transient engorgement from atmospheric irritation or vaso-motor relaxation, but only upon those showing true hypertrophy: the distinction is made manifest by cocain. If the whole turbinal shrinks down to a minimum, it is not hypertrophy; but if some remains, especially if it is pale, flabby, and less easily compressible, then it is a true hypertrophy and will permit the use of these agents. The galvano-cautery tip can be used in two ways in these cases: the point being heated to a cherry-red color, a line can be drawn on the lower edge, and on one or two parts of the face of the third turbinals or along the middle, or one or both sides of the second or middle turbinals; or one or more lines may be drawn along that swelling of the septum so often occurring over the suture between the ethmoid plate and the triangular cartilage. Some have decried the cauterization of the second turbinal, fearing meningitis by extension of inflammation or other evils. But this fear is probably not well grounded unless the operation were done where there was so much swelling in the lower parts of the nose as to make drainage poor or *nil*. For this reason the lower parts of the nose should be treated first, and after healing has taken place it will be safe to treat the upper parts.

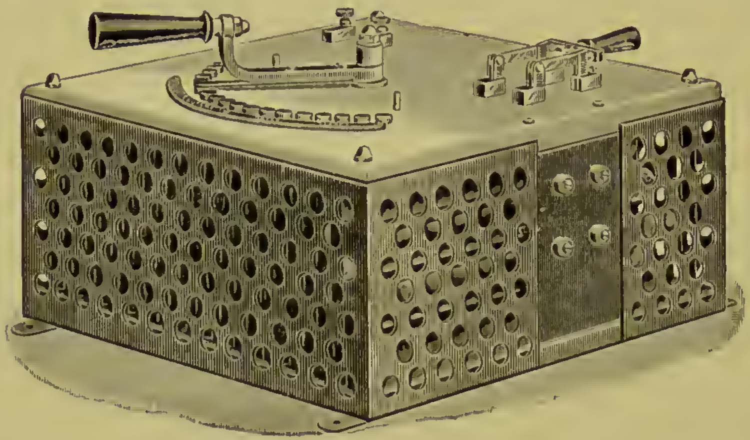

FIG. 567.—Rheostat or commutor for adapting the street current to cautery use.

This "lining" of the surface of the intranasal swellings, however, causes much destruction of the ciliated epithelium and of the glandular layer under this; healing is then sometimes rather tedious, and there is danger of synechiæ if the lumen is narrow. Hence, it is at times better to puncture the anterior part of the swelling and to carry the heated point backward as far as is necessary in the cavernous layer parallel to the outer surface. For this purpose the platinum part of the point may be made longer than usual, say three-fourths of an inch in length. In this way only a small round point of the surface is destroyed and healing is more rapid. A flow of blood is apt to follow the extraction of the point, but can be controlled by withdrawing it slowly and then sealing the aperture with the still glowing point. A white heat is not hemostatic.

FIG. 568.—Cautery-point.

The best handle is that of Scheeh, and he has also probably brought the points to the greatest perfection as to their form. If the copper part of the electrode is too small, it will get disagreeably hot before the operation is finished; this adds much to the nervous apprehension of the patient if it is felt. The copper part should, therefore, be large enough to keep the platinum heated without itself getting hot. This principle is carried out in points made by the Edison Company.

The use of the galvano-cautery on hypertrophied tonsils is advocated by many. In the opinion of the writer, however, it is irrational and dangerous. The inflamed tonsil (especially in the lacunal variety) is large because of morbid processes and products in the crypts. Unless the electric point is carried to the bottom of these crypts and the whole of the interior treated, some of the *materies morbi* is left after the adhesive inflammation has sealed the outer part of the lumen (there is the same objection to the ordinary amputation with the guillotine); and if it is carried to the bottom it comes too near the capsule and the large vessels lying just to the outside. Enucleation or discission (as first advocated by Hoffman and elucidated by the writer, *Boston Medical and Surgical Journal*, Oct. 12 and 19, 1893) seems much more rational. Moreover, the galvano-caustic method of reduction requires several sittings, and thus keeps the throats of most patients in a state of painful inflammation longer than does discission, which may need but one or two sittings.

The use of the galvano-cautery or of other caustics is fortunately not often required in the larynx, but may be indicated in some cases of tumefactions. For example, lactic acid (40 per cent. to 100 per cent.) has been very highly praised in tubercular nodules and ulcers; and nitrate of silver, fused on Shrötter's concealed applicator, in papillomata or pachydermia among others. But the use of the galvano-cautery for singers' nodes (pachydermia tuberosa) as advocated is, in most cases, entirely uncalled for, since absolute rest will cause their disappearance in a very few weeks, with much less danger to the delicate edges of the vocal cords.

PROGNOSIS.

The question is often asked of the specialist, "Can my catarrh be cured?" or "Can it be cured permanently?" The first of these questions can generally be answered in the affirmative, except in some very bad cases of atrophic nasal catarrh or of destructive specific ozena; and the second also in the affirmative, as truly as in any other affections of the mucous membranes. Recurrences are to be expected or to be guarded against in most ills to which human flesh is heir, except perhaps death or those which can be permanently shut out by surgical measures, such as enucleation of an eye, or amputation of a limb, or removal of the appendix vermiformis: then why not a recurrence of catarrhal conditions to be brought on by the same means as previous attacks? But it is altogether probable that if all contacts are abolished in the nose by removal of extraneous growths and by reduction of abnormal swellings of normal structures without destroying the functions of the parts, so as to establish the habit of nose-breathing; if purulent cavities are drained and allowed to heal, whether of the accessory sinuses or other sources of pus emptying into the nose; if caries or necrosis of hard or soft parts can be stopped and their products removed so as to be no longer the source of irritation as foreign bodies; if bad habits are corrected and the daily life brought into rational physiological channels; if troublesome or deleterious dyscrasia and diatheses can be eliminated or held in abeyance—then probably the symptoms of catarrh can be abolished. So that in most cases the patient may be promised that he can be cured or, if not cured, made so much better that he will consider himself cured, till by his own carelessness or misfortune causes operate to induce a new manifestation of his trouble.

These same questions are almost always asked by anxious parents when hyperplasia of the pharyngeal tonsil has been discovered in their children. It seems to the writer that an affirmative answer can always be given, provided the nares are unobstructed and the habit of nasal respiration is immediately established. No statistics are at hand; but it is probably true that habit and hypertrophic nasal obstruction are the great factors operative in cases of recurrence. *Per contra*, given an obstructed nose and adenoid vegetations, it is often safe to give the prognosis that the latter may wholly disappear or cease from troubling, provided they are not too old and hard, if the former is restored to normal caliber and mouth-breathing stopped. This desirable result has been attained in the practice of the writer more than once; and the cases of recurrence which have formerly come under his observation were in children with obstructed noses or whose parents did not insist on nasal respiration.

In closing this article, a word as to the danger of too much or too radical surgical interference in the upper air-passages deserves a place. Destruction of tissue in the nose should be limited to the hard parts as much as possible. It is a great mistake to remove the lower turbinals except for necrosis, although much of their covering may be redundant. The posterior ends may be amputated, the middle and anterior ends may be prodded and scored with the cautery and any excrescences removed, but not enough to shrivel them into cicatricial masses without function. The whole body even may be bent downward and outward on its attachment like a hinge, but it is protested that it should not be destroyed nor removed. Atrophic rhinitis, dry, crusty, malodorous catarrh, pharyngitis sicca, and chronic inflammation of the surfaces lower down threaten the victim of such mistaken zeal, if not immediately, surely in the near future. The middle turbinal is functionally less important and may even be removed with less danger of future evil when it suffers edematous mucous degeneration (so-called) or caries, or becomes cystic and enlarged, causing painful disturbance of the fifth nerve by pressure. 'Twere better to reduce its size by the various means suggested, but even then its ability to keep its surface clean should not be impaired.

It is significant, as Chapell and others have shown, that even by ordinary operations in the nose in certain individuals reflex neurosis may be set up, producing exaggerated nervous symptoms especially as to the nose itself, inability to apply the mind, and even melancholic depression. Perhaps in no branch of surgery, then, is there more need of caution than in this region.

It is obvious also that the mucous membrane of the naso-pharynx should not be removed with the pharyngeal tonsil, nor the pillars of the fauces with the faucial tonsil, nor in the larynx should the delicate edges of the vocal cords be injured, nor other part wounded so that cicatricial bands may impair its shape or movements. In fine, in all this region of the upper air-passages, the operator should have ever in mind the inflexible rule that if he cannot reach the perfection of his ideals, he certainly must make the patient no worse in any particular.

ACUTE AFFECTIONS OF THE NOSE.

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Acute Rhinitis.—Acute rhinitis, *or coryza,* colloquially termed "cold in the head," is an acute inflammation of the mucous membrane and submucous tissues of the nasal cavities, the naso-pharynx being usually likewise involved, at least to some degree. It not infrequently affects the ears, *via* the Eustachian tubes, and is prone to extend to the pharynx, larynx, and bronchioles. This sequence may on occasion be reversed, the rhinitis following an initial inflammation in the lower respiratory tract; or the whole surface may become inflamed at one time. Also, the maxillary, frontal, and sphenoid sinuses and the ethmoid cells, being cavities immediately contiguous to the nasal chambers proper, can rarely wholly escape; and at times one or more of them may present, as a complication, an acute sinusitis far more grave than the original rhinitis.

Etiology.—While local inflammation is the salient feature of an acute "cold in the head," there is reason to believe that a fundamental disorder of the nerve-centers leading to vaso-motor paresis is associated therewith. Reasoning from analogy and from pathology and clinical history, one must regard acute suppurative rhinitis as an infection by pathogenic micro-organisms, although germs specific to this particular form of suppuration have not as yet been identified. However, certain local and constitutional conditions seem to favor infection, and the latter ensues finally under the influence of vascular disturbance which has been excited by some sort of exposure.

1. Chronic hypertrophic rhinitis, obstructive deformities of the septum, and adenoid vegetations probably, by maintaining local congestion and stenosis, favor recurrent attacks of acute rhinitis.

2. Extreme bodily fatigue or nervous exhaustion, the physical lassitude engendered by excesses, and the tuberculous and syphilitic dyscrasiæ render the individual more vulnerable upon exposure. The habit of hot bathing, especially previous to going out in cold weather, is a prolific underlying source of rhinitis. These, as well as the custom by many of wearing too heavy apparel and living in overheated apartments, seem to exert a softening influence upon the bodily surface, lessening its resistance to draughts and climatic inequalities.

3. In the presence of such local or constitutional predisposing conditions, acute rhinitis follows certain exposures with such regularity and precision that one must infer a causal relationship to exist between chilling of the body and rhinitis. A draught between the shoulders, permitting the feet or other parts of the body to become cold and damp, exposure to bleak winds, as in driving in an open vehicle, or too rapid checking of the perspiration, causes through the intervention of the vaso-motor nervous system a sudden turgescence of the nasal vessels, especially of the turbinal bodies. In the majority

of instances this congestion is but transitory, passing off in a few hours and followed merely by increased secretion; but in other instances it does not subside, but augments in violence, and is followed in twelve to twenty-four hours by a muco-purulent and then almost a purulent discharge. This congestion of the nasal vessels occasioned by thus "taking cold" seemingly favors a microbic invasion of the mucous membrane by impairing in some manner its power of resistance.

Extreme heat of weather, especially when accompanied by enervating dust-laden winds and acting upon individuals in a state of fatigue, is capable of exciting a form of acute rhinitis colloquially termed "heat-cold." In like manner a much overheated sitting apartment or assembly hall, or a journey in a superheated railroad car can have a similar result. In fact, a "cold" results quite as frequently from getting too hot as from being too cold.

Again, the subjects of supersensitive nasal mucous membranes may suffer from pronounced nasal irritation when exposed to the inhalations of various atmospheric impurities—*e. g.* the dust of railroad travel, the smoke and fumes of large cities, particularly when combined with fog, as is often the case in London and Chicago, different kinds of pollen, and even the aroma from horses. Asthmatic symptoms occasionally supervene upon this variety of nasal irritation, and the whole picture differs somewhat from that of an ordinary acute rhinitis, partaking more of the condition which in its typical form is known as "hay-fever" or vaso-motor rhinitis.

Instances are not wanting of direct infection of one person by the discharges of another—an accident which is apt to happen among children by the use of handkerchiefs in common. Suppurative rhinitis in infants is also attributable to direct infection from the vaginal discharge during birth, and this infection may be of a gonorrheal nature. Acute blennorrhea is another term applied to suppurative rhinitis with profuse secretion. The infecting agent may be the gonococcus or other pyogenic micro-organisms.

Rhinitis is one of the salient manifestations of genuine influenza; it is an initial symptom of measles; and quasi-rhinitis is a prominent characteristic of iodism, and to a less extent of cinchonism. It is apt to occur during pregnancy and is then aggravated by the passive venous congestion which is incidental to that state.

Symptoms.—A sense of stuffiness in the nostrils, with sneezing, burning, and dryness, together with malaise and a slight febrile reaction, is succeeded in a few hours by an acrid watery discharge, which later leads to a free muco-purulent secretion. A simultaneous congestion of the frontal sinuses will occasion headache; but this does not argue pressure by accumulated muco-purulent secretion within these cavities, for actual empyema of the frontal sinuses is rare. Much discomfort results from the partial or complete occlusion of the nares, especially at night, the patient necessarily breathing in part through the mouth, which occasions dryness of the throat and a sense of dyspnea; small children will actually struggle for breath and even suffer attacks of laryngismus stridulus excited in consequence. The sense of smell is obtunded or for the time suspended, and that part of taste which is dependent on the olfactory sense is impaired. A symptom which becomes a serious inconvenience to public speakers and singers is alteration in the quality of the voice, which acquires a guttural and so-called "nasal tone" because of limitation of the resonance-space by intranasal swelling. The anterior nares become red, sensitive, and excoriated.

On inspection by means of a nasal speculum and reflected light the mucous membrane appears of a darker red color than usual and the turbinal bodies swollen. At times, however, especially at the second stage—that of profuse serous discharge—the turbinal bodies of now one and then the other side may appear collapsed. At the third stage quantities of muco-purulent secretion will be observed. Posteriorly the conditions and aspects are similar.

Diagnosis.—From erysipelas, acute rhinitis is distinguished by the gravity of the former affection and the erysipelatous hue which will gradually extend over the lip and nose externally. The nasal irritation from a foreign body is unilateral; that of measles is indistinguishable from simple acute rhinitis until the cutaneous eruption appears; that of iodism will be associated with cutaneous papules and will promptly cease on withdrawal of the drug. Hay-fever occurs in August and September; the patient will perhaps have a history of previous attacks, and in any event the sneezing, burning, post-nasal and lachrymal irritation endure without diminution or change for a period much in excess of simple acute rhinitis.

Prognosis.—Simple acute rhinitis, uncomplicated by serious implication of the collateral sinuses or of the ear, will spontaneously terminate in recovery in from five to fourteen days. Nevertheless treatment should not be neglected, for it will certainly lessen the severity and duration of the disease and tend to prevent complications or a transition into chronic nasal catarrh.

Treatment.—Sufferers should receive the benefit both of immediate treatment and of wise prophylaxis. At the time of an attack many remedies are of real service; but a multiplicity of recommendations is confusing and tends to lessen confidence in any one line of treatment. I will therefore describe simply my own methods of dealing with these cases.

If it is sought to abort the disorder, a single average-sized dose of Dover's powder or of morphin or codein is given at bedtime, also a laxative if needed. The morphin may be combined with atropin to advantage, as in the customary hypodermic tablet—*e. g.*, morphin sulphate, gr. $\frac{1}{6}$, and atropin sulphate, gr. $\frac{1}{120}$. The patient is especially well covered in bed, outside air is excluded, and the temperature of the apartment maintained during the night at 60° to 70° F. This will usually result in a slight excess of secretion from the skin, but no effort is made to produce profuse perspiration. If a decided sudorific effect be desired, a sort of "Turkish bath" may be extemporized previous to retiring by seating the patient, enveloped in a blanket, upon a chair beneath which a small lamp is caused to burn. In the morning on rising three ounces of Rubinat saline water should be taken, provided a laxative has not been administered the night before. If convenient, as in the case of many ladies, confinement to the house for a day or two will insure a prompt recovery.

Quinin has acquired notoriety among laymen as an abortifacient agent; but it is unreliable, and seems even at times to aggravate the condition. Cocain, in the form of a spray, only exceptionally succeeds in actually aborting the disease, although it affords temporary relief; and one is also disappointed in the alleged effects of antipyrin similarly used for the same purpose.

During the course of the affection I have most frequently prescribed prepared "rhinitis-tablets" (Dr. Lincoln's formula, one-half strength), one every two hours, which are composed as follows:

℞.	Ext. belladonnæ fld.,	gr. $\frac{1}{8}$	.008;
	Camphoræ,	gr. $\frac{1}{4}$	.016;
	Quininæ sulph.,	gr. $\frac{1}{4}$	.016.—M.

although other remedies—*e. g.*, aconite, potassium bromid, strychnin, or codein—may be indicated at particular stages; aconite and potassium bromid early when there is fever, and strychnin later to stimulate the paretic vaso-motor system. Codein or morphin conjoined with atropin in small doses is serviceable when there is a harassing cough; and even for the rhinitis itself during the first few days it would be an excellent remedy if it were not for well-known objections to its continuous or general use.

Local treatment is of the utmost importance, and the following mixtures render satisfactory service by atomization:

Spray No. 1.

℞.	Menthol,	gr. j	.065;
	Ol. eucalypti,	♏iij	.2;
	Ol. gaultheriæ,	♏iij	.2;
	Sodii bicarbonatis,	gr. xv	1.;
	Sodii boratis,	gr. xv	1.;
	Glycerini,	ʒiij	12.;
	Aquæ,	q. s. ad., ℥j	32.—M.

Sig.—Dilute, adding one teaspoonful of medicine to one ounce of warm water for use as a spray.

Spray No. 2.

℞.	Menthol,	gr. j	.065;
	Ol. pini pumilionis,	♏ v	.35;
	Ol. gaultheriæ,	♏iij	.2;
	Ol. eucalypti,	♏iij	.2;
	"Benzoinol,"	℥ss	15.;
	"Oil vaselin,"[1]	q. s. ad., ℥j	32.—M.

Sig.—Use with a double-bulb (Davidson) atomizer, either alone or following the use of Spray No. 1.

In office practice it is quite customary to spray first with a ½ per cent. solution of cocain, followed in five minutes by Spray No. 1, and this in turn by the emollient Spray No. 2.

At home either Spray No. 1 or Spray No. 2 or both may be used every three hours or according to convenience.

To Spray No. 1 can be added a minute quantity of cocain hydrochlorate equal to ⅛ per cent. when diluted; but then care must be observed not to use the spray with greater frequency than every two or three hours, as the too frequent use of even diluted solutions of cocain in the nose results in a reactionary turgescence of the conchæ and, in susceptible individuals, in systemic disorder of the nervous system and irregularity of the heart's action. In fact, one should avoid as far as possible prescribing or placing cocain in the hands of patients; for the sensations engendered by its nasal use, together with the cerebral stimulation by absorption through the nasal mucous membrane, are so enticing as to tempt the patient not only to too frequent and profuse use of the substance for the time being, but also to the formation of a chronic cocain habit.

For young children, who are often terrified by spraying, may be substituted a small syringe or an ordinary medicine-dropper used as a syringe, with which to project gently either of these spray solutions through the nostrils. All solutions for nasal use should be somewhat warm.

Of the many vapor inhalations I would mention camphorated steam as a domestic remedy of power. It is conveniently used by placing a pint of

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[1] By "oil vaselin" is meant the yellow opalescent oil free from kerosene odor.

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steaming hot water in a glass fruit-jar and adding two drachms of spirit of camphor: a funnel, preferably of glass, is then inverted to cover the mouth of the jar, and the rising steam is inhaled through the nostrils as it escapes from the small end of the funnel. So used, especially during the evening for a half hour, it conduces to a comfortable night's rest and facilitates recovery. The inhalation of steam through a sponge wrung out of hot water is another domestic expedient. The vapor from a few drops of a mixture of equal parts of spirit of ammonia, carbolic acid, and cologne, inhaled from cotton stuffed into a paper cornucopia, conduces to the comfort of the sufferer, as do pocket-inhalers which contain menthol or its combinations.

When intumescence of the turbinal bodies continues to be annoying beyond the usual period of actual acute inflammation, immediate relief will be afforded by two skilfully-made electro-cauterizations after the manner much in vogue for chronic hypertrophic rhinitis.

Prophylaxis.—Those who are exposed to climatic inequalities, and who would at the same time escape recurrent attacks of acute rhinitis, should seek in their mode of life to conserve and increase a natural resistance. To this end, no hygienic detail is of greater importance than the habit of cold bathing immediately on rising in the morning. The bath may be of the plunge, shower, or wet-towel variety, with the water at a temperature of 50° to 56° F., taken in a reasonably warm room and followed by friction with a linen crash towel, and this by brief calisthenic exercises. Patients who have a fancied repugnance to cold water are directed to commence by simply rubbing the whole surface of the body quickly with a wet crash towel. The cold bath invigorates the vaso-motor nervous system, accustoms the cutaneous surface to changes of temperature, and generally augments the bodily tone. This "hardening process," to get the best effect, should be supplemented by regular and persistent open-air exercise in all kinds of weather. When properly clad even delicate patients may safely be discouraged from omitting their outings simply because it rains, snows, or blows. To remain indoors because of trifling inclemency in the weather means at certain seasons an uninterrupted confinement to hot and ill-ventilated rooms for days at a time, with all the softening effects that such a mode of life invokes.

As to clothing, it is a golden rule to keep comfortable, avoiding an excess of raiment even more assiduously than a deficiency; and changing even to the underwear as frequently as required by variations of temperature. For instance, on a sultry late November day it is certainly less hazardous to rechange to lighter wear than to endure the general relaxation incidental to being overclad. Even in winter, extra-thick underwear is undesirable for those who live chiefly indoors, a light grade of good woollen material, supplemented by varying grades of outer clothing and overcoats, being best. For spring and fall a still lighter article either of good merino or wool, and for midsummer balbriggan or even gauze, is suitable for the ordinarily robust individual. Chest-protectors are abominations, and neck-mufflers are permissible only on extreme exposure. Ordinarily leather will not keep out moisture; and wet or even damp feet in cold weather, endured for hours without opportunity to change, is a prolific cause of "colds." A protective overshoe, as low as will answer the purpose and removed on passing indoors, is therefore a necessity.

Living apartments and offices should not be heated beyond 70° to 72° F., and means should be provided for reasonable ventilation and for imparting to hot air a degree of humidity; however, when the other conditions above mentioned are complied with, the baneful effects of oftentimes uncontrollable superheating become much less manifest.

Finally those individuals who are predisposed to acute rhinitis by reason of adenoid vegetations, chronic hypertrophy of the turbinal bodies, obstructive deformities of the septum, or nasal polypi, should have such affections remedied by accepted methods, supplementing this treatment by observance of the laws of hygiene.

Membranous Rhinitis.—Membranous rhinitis, also termed croupous rhinitis and rhinitis fibrinosa, is an acute inflammation of the nasal passages accompanied by a whitish membranous exudate which covers the whole or parts of the inflamed mucosa. A membranous exudate frequently forms in consequence of chemical or electro-cauterization of the turbinal bodies; but this condition differs essentially from genuine membranous rhinitis. The exudate is thick, gray-white in color, confined to the immediate vicinity of the canterized site, which it overlaps somewhat, shading off to a thin edge a little distance from the center of the most intense inflammatory action. If this pseudo-membrane be forcibly detached on the second day, it redevelops; if allowed to remain it becomes incorporated with the eschar produced by the cautery, and the whole will separate spontaneously like an eschar about the fifth day. There is no evidence that such a membranous exudate results otherwise than from a regenerative type of inflammation following the application of an intense and destructive irritant. Contaminating micro-organisms are found; but to them cannot be attributed the initial pathogenic rôle. It is of importance chiefly as an object lesson, serving to remind one that all membranous exudates are not to be ascribed to a single cause, and that, however ubiquitous the Klebs-Löffler bacillus may be, there are yet other agencies capable of producing an inflammation of the membranous type.

As in the throat, so also in the nose, an exudate like that of membranous rhinitis proper can doubtless ensue from infection by any one of several species of pathogenic micro-organisms; in many of the cases only staphylococci and streptococci have been found; while in others of identical clinical course Klebs-Löffler diphtheria bacilli have been demonstrated—albeit oftentimes sparse in numbers, of questionable virulence, or mixed with other microbes. Of twenty-two cases which were subjected by Edmund Meyer[1] to both microscopic and bacteriologic investigation with animal experiments, in thirteen virulent diphtheria bacilli were present, and in nine there were streptococci of little virulence and the staphylococcus pyogenes albus and aureus. The clinical course in both series of cases was essentially the same.

It is true that the disease which has acquired the name of membranous rhinitis, even when the diphtheria bacillus is associated therewith, differs radically in symptomatology from typical nasal diphtheria. Its manifestations are chiefly local, it is not accompanied by constitutional symptoms other than those of a "cold in the head," and it shows but little disposition to extend to the throat. Hence in those cases in which the Klebs-Löffler bacillus has been reported, it has sometimes been suggested that this in reality might be the pseudo-diphtheria bacillus of Hoffmann, which is little virulent, but which morphologically, studied only by the microscope, is quite similar to the diphtheria bacillus. As is now well-known, the pseudo-bacillus is viewed by Escherich as an independent organism, but by Roux and Yersin as an attenuated form of the Klebs-Löffler bacillus. Again, since diphtheria bacilli are occasionally present in healthy throats, and as their detection alone, unaccompanied by the usual symptoms, hardly suffices for a diagnosis of diphtheria, so also in the nose the presence of a few such bacilli does not render it certain that they constitute the responsible cause of the membranous rhinitis. In this connection, Dr. W. H. Gross,[1] of the Children's Hospital of Boston, presents valuable corroborative evidence. Weekly culture examinations were made from the normal throats and noses of 300 children, the Klebs-Löffler bacillus being found in 8 per cent. of the cases. Of this number the nose was the habitat in 65 per cent. and the throat in 35 per cent. In none of these did clinical diphtheria develop.

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[1] *Archiv f. Laryngologie*, etc., Vierter Band, Heft 2, S. 253.

However, since in Edmund Meyer's thirteen cases all the Klebs-Löffler bacilli were found to be virulent, it is impossible to escape the conclusion that these cases at least were of diphtheritic origin, and that there are conditions not yet definitely known, pertaining to the resistance of the individual or to the degree of virulence and number of the micro-organisms, which determine a wide variation from the usual clinical picture of nasal diphtheria. Until these conditions are better understood such cases will be found classed under the designation "membranous rhinitis;" although it is expected that in the immediate future the general term "diphtheria" will have appropriated most of them for its own.

Etiology.—From an etiologic point of view one may therefore divide so-called membranous rhinitis into two types: diphtheritic and non-diphtheritic. Corroborative evidence of the identity of the diphtheritic type of membranous rhinitis with true diphtheria is occasionally obtainable in a definite history of exposure to infection while in attendance upon diphtheria patients.

Case I.—Miss ———, a trained nurse, applied for treatment at St. Luke's Hospital, complaining of obstruction of the left nostril, which she had at first attributed to a "cold." The inflammation had commenced while she was nursing a diphtheria patient, and she had been under the treatment of her patient's physician for about eight days. During that time the passage was occluded by a white membranous exudate, pieces of which were detached by forceps and subjected to bacteriological examination, disclosing Klebs-Löffler bacilli. On personal examination at the end of the eighth day the vestibule of the nose and the upper lip were found tumefied and incrusted by an excoriating discharge, while the septum and anterior part of the inferior turbinal body were still covered by a thin whitish exudate. On account of the swelling it was impossible to determine the exact extent of the exudate; but none was visible by posterior rhinoscopic examination. A culture taken at this time again disclosed Klebs-Löffler bacilli mingled with cocci. The right nostril, while somewhat inflamed, presented no exudate. The patient had not complained of any constitutional symptoms whatever, but appeared worn-out and anemic: she had continued her nursing duties to the end and left the hospital the same day to rest at her own home.

Case II.—Dr. S———, a young physician, was interne at the Children's Free Hospital of Detroit during an epidemic of diphtheria. A few days after the cessation of this continuous exposure he noticed an inflammation in the left nostril, which progressed to the point of total occlusion by swelling and a white exudate, with an excoriating discharge. He stated that this exudate had been so plentiful that shreds could readily be detached. He was examined about the seventh day, at which time the membrane consisted of a mere film covering an excoriated surface which embraced the vestibule, the cartilaginous septum, and the anterior part of the external nasal wall, extending backward not exceeding three centimeters. A culture was taken and examined by Dr. Gehrman, of the Chicago Health Department, in conjunction with his assistant and the patient himself, who reported the presence of Klebs-Löffler bacilli. There were no constitutional symptoms, and convalescence was complete in three weeks.

It is thus seen that a liability to the dissemination of diphtheria lurks in the diphtheritic type of membranous rhinitis; it doubtless escapes medical observation and treatment many times, being regarded by the parents of the affected children simply as a "cold," while in reality, from etiologic and pathologic standpoints, it is veritable diphtheria, differing only in degree rather than in kind. Nevertheless, one is not justified in assuming all cases of membranous rhinitis to be diphtheritic, for in many the most careful search has disclosed only cocci. The crucial test lies in the microscopic examination of a culture, which should be deemed imperative in every case.

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[1] *University Medical Magazine*, Oct., 1896; *Medicine*, Nov., 1896.

Pathology.—The structure of the pseudo-membrane is similar to that which occurs elsewhere in diphtheria. Microscopically, it is composed of proliferated epithelial cells in a fibrinous network.

Symptoms.—The symptoms are much the same for both types of the disease, and are ushered in by dryness and fulness of the nostrils with persistent tickling; later there is a free discharge, watery at first, but becoming thick and tenacious. By the third day an exudate will have formed, which, if torn away by forceps, leaves bleeding points and soon re-forms. The fibrinous deposit may occur in one or both nostrils and may embrace any or all parts of the passages, extending a variable distance backward. It rarely embraces the throat, although it may do so; or rather in these instances it seems to originate in conjunction with acute infectious pseudo-membranous inflammation of the faucial and post-nasal tonsils. Much discomfort ensues from the total occlusion of one or both nostrils and from the excoriation and tumefaction of the anterior nares, the external nose and upper lip being at times so red and swollen as to suggest erysipelas. In fact, it is likely that the micro-organism of erysipelas may be one of those capable of producing membranous rhinitis. These conditions are well exemplified in

Case III.—Dr. D——— had been exposed by attendance upon a case of scarlet fever with membranous deposit in the pharynx. He was taken ill with the characteristic symptoms of acute infectious pseudo-membranous tonsillitis. Within the right nostril was observed a distinct exudate covering the vestibule, cartilaginous septum, inferior turbinal body, and other parts as far as one could see. It differed from the ideal diphtheritic deposit, being thinner and semi-translucent, and had more the aspect of epithelial débris; but was evidently not merely such. The nose externally was swollen and of a decidedly erysipelatous hue, the redness being confined, however, and not extending above the bridge of the nose.

Diagnosis.—This will depend upon attention to the salient features already described; if seen late, after the characteristic appearances have subsided, it might be mistaken for simple rhinitis which had led to excoriation of the vestibule or for secondary syphilis. Erysipelas should be kept in mind.

Prognosis.—The disease has endured usually for about three weeks; nor has this period varied in consequence of treatment, although the comfort of the patient is conserved by remedial measures.

Treatment.—For the diphtheritic type of membranous rhinitis antitoxin should be injected, provided the condition assumes a degree of gravity. One would expect this to ameliorate the condition and shorten the duration of the disease.

For the non-diphtheritic type the tincture of the chlorid of iron internally best meets the indications. Locally a variety of medicaments have been used; often, however, with disappointing results. Cocain in 2 per cent. to 4 per cent. solution fails to exert its customary degree of retraction; but wisely employed, especially by means of cotton tampons, it affords relief and is serviceable preceding the application of other remedies. In my own cases, following the cocain I have applied satisfactorily by tampons this lotion:

℞.	Resorcin,	gr. xv	1.;
	Ol. amygdalæ,	ʒiij	12.;
	Glycerinæ,	ʒij	8.;
	Alcohol,	℥iij	10.—M.

For its destructive effects upon the membrane a weak solution of one of the iron preparations has been commended. Löffler's solution, appropriately diluted for nasal use, might be substituted. It is composed as follows: Menthol, 10 gm.; toluene, q. s. ad., 36 c.c.; creolin, 2 c.c.; iron chlorid solution, 4 c.c.; alcohol, q. s. ad., 100 c.c. Medicaments which smart and irritate the nostrils for any length of time had better be avoided or their strength reduced. For his own use an alkaline and antiseptic spray conduces to the comfort of the patient—*e. g.:*

℞. Menthol,	gr. $\frac{1}{3}$	.22;
Ol. eucalypti,	gr. xv	1.;
Ol. gaultheriæ,	gr. xv	1.;
Sodii bicarbonatis,	ʒj	4.;
Sodii boratis,	ʒj	4.;
Glycerini,	f ℥iss	45.;
Aquæ,	q. s. ad., f ℥iv	120.—M.

Sig.—To be diluted by adding one to three teaspoonfuls of medicine to an ounce of water for a spray.

Abscess of the Nasal Septum.—The condition which for the sake of simplicity in nomenclature is designated "abscess of the septum" only occasionally presents the typical characteristics of acute circumscribed suppuration. When caused by traumatism, the first stage may be an effusion of blood beneath the muco-perichondrium of the cartilaginous septum, which is termed "hematoma of the septum." In time the blood degenerates, perhaps becomes infected by pyogenic micro-organisms, and changes to a brownish-yellow fluid, which when evacuated appears neither like blood nor typical pus. In this state it has been called "cold abscess." Again, when it originates without traumatism and runs an acute course, with pain, fever, and obstructive swelling, terminating in ideal suppuration, it has been spoken of as "acute perichondritis." Jurasz[1] has described a form in which the contained fluid is at first serous, termed serous perichondritis. Some sort of abscess is the culminating stage of all these conditions (see page 1117).

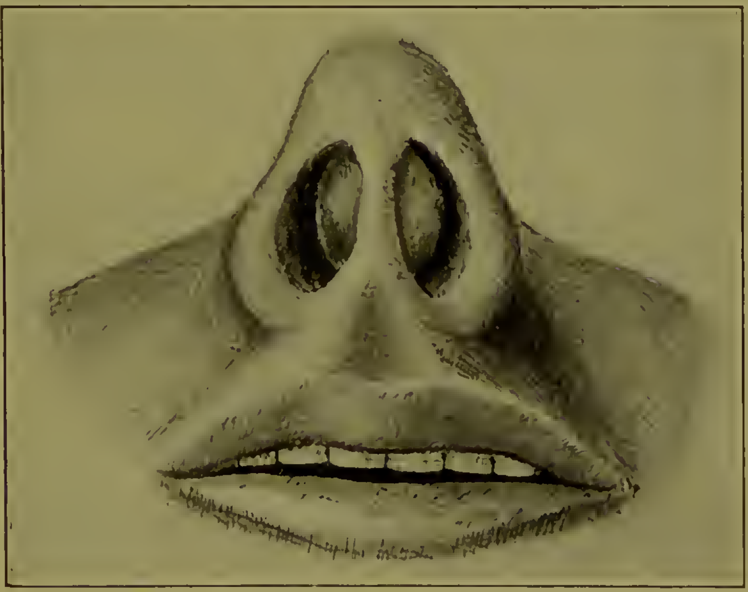

FIG. 569.—Abscess of the septum, protruding bilaterally.

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[1] *Journal of Laryngology*, etc., Nov., 1896, p. 266.

Although it might be possible for the bony portions to be affected, the usual seat of the disease is the cartilaginous part of the septum, and it may be either unilateral or bilateral.

Etiology.—The most frequent cause is believed to be traumatism—*e. g.* blows or falls upon the nose; yet in many cases it is impossible to establish this relationship. Slight contusions, readily forgotten, can determine a hematoma of the septum. This may run an insidious course, endure for days or weeks, and undergo spontaneous absorption, having been little noticed; but in other instances the blood changes to sanguinolent pus and the cartilage itself disintegrates, the abscess-contents being retained by the bulging muco-perichondrium. Pyogenic micro-organisms could excite suppuration in these and also in so-called idiopathic cases by gaining an entrance through the excoriations which are frequent on these surfaces. The disease may occur also during the course of typhoid fever or small-pox; and Schech[1] calls attention to the frequency with which facial erysipelas proceeds from abrasions upon the septum, and infers that abscess of the septum can be caused by infection by the streptococcus erysipelatus. In many cases still it is quite impossible to assign any definite cause. This was true in the following case, which is a typical example of the variety termed cold abscess:

Case I.—Master G——, aged sixteen years, while away from home at school, began to suffer from nasal obstruction, which he attributed to an acute exacerbation of his customary "catarrh." No history of traumatism could be elicited, the disease having seemingly commenced as a cold and continued several weeks before it received serious consideration. But nasal obstruction and swelling within and without the nose gradually grew so serious that he was sent home, where he was confined to bed, supposed to be suffering from asthma. On examination the diagnosis was at once apparent, for from each side of the septum bulged a fluctuating tumor which completely blocked both nostrils. The enveloping mucosa was unbroken, somewhat inflamed, and the nose generally reddened and edematous. A brownish-yellow liquid was withdrawn by a hypodermic syringe, and this was followed by a free incision toward the base of one side and gentle curetting of the cavity. The central portion of cartilage had liquefied; but it redeveloped from the muco-perichondrium and perfect recovery ensued.

Symptoms.—In case of the transition of a hematoma into an abscess, the disease may manifest itself either quite insidiously or the suppurative change may ensue quickly and be associated with sneezing, general nasal irritation, and slight fever. In either event the salient symptom ultimately complained of will be obstruction to nasal respiration, together with the discomforts of mouth-breathing.

When the abscess arises in the form and in consequence of acute perichondritis, it is ushered in during a few days by symptoms indicating a high degree of inflammation—*e. g.* chill, pronounced fever, swelling and redness of the whole organ. Spontaneous rupture is more apt to occur quickly in this than in the former type, although it may be much delayed after the subsidence of the inflammatory symptoms, leaving again nasal obstruction as the salient symptom.

Case II. exemplifies the latter type. Mr. ——, aged twenty-six years, thought he had contracted a severe "cold in the head," the condition commencing with chilly sensations, followed by headache, fever, local sensitiveness, and redness extending to the bridge of the nose. These symptoms gradually subsided, but were replaced by nasal obstruction and what he now supposed was chronic nasal catarrh. The examination was not made till the third week, when a fluctuating tumor was observed to bulge from each side of the septum. Typical pus was evacuated by an incision and the cavity curetted. The destroyed central part of the cartilage ultimately redeveloped without deformity. He positively denied the least probability of traumatism as a cause.

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[1] *Die Krankheiten der Mundhöhle, des Rachens und der Nase*, 5 Aufl., 1896, S. 298.

Diagnosis.—By simple inspection with the head tilted backward the semicircular tumor may be seen bulging from one or both sides of the septum (Fig. 569). Palpation by a probe will cause deep pitting or even fluctuation, and aspiration by a hypodermic needle will provide a sample of the contents. It may thus be readily distinguished from polypus, for which it is most commonly mistaken by novices, which occurs but rarely in this situation; and also from syphilitic gumma, which commonly develops at just this spot. I have seen one case of gumma, in which the central part had liquefied before the occurrence of superficial ulceration, in which the diagnosis would have been impossible had not other syphilitic signs been present.

Prognosis.—If recognized reasonably early and the abscess evacuated, the prognosis is very good. Notwithstanding complete liquefaction of the cartilage itself, if the muco-perichondrium be preserved another cartilaginous septum will develop, and this usually without deformity. However, if the disease be unrecognized or if the inflammatory action extend to the antero-superior border of the septum, the line of junction of the septum with the lateral cartilages and nasal bones, softening and depression of these, which constitute the dorsum of the nose, will result. Apart from this "saddle-back" deformity or in conjunction with it, perforation of the septum can also ensue.

Treatment.—When the initial stage is a hematoma, cold applications would be suitable. In any event, as soon as pus is present a rather free incision should be made low down on one side and the contents expressed. This should be reopened daily with a probe until the cavity has been effaced. It is probably not necessary to curette, wash out, or pack the cavity with gauze, although one or all of these may seem desirable at times.

Abscess and Furuncle of the Nasal Wing.—Furunculosis of the wing of the nose is of frequent occurrence and results commonly from infection or irritation in or about the hair-follicles, as from pulling out hairs. The boil is usually quite small, scarcely more than a "pimple," but is accompanied by an amount of tenderness, swelling, and redness of the nasal appendage quite disproportionate to its size. It points inside the wing of the nose in a position difficult of observation even with a nasal speculum, but it can be exposed to view in a small rhinoscopic mirror held just within the vestibule. It should be punctured as soon as suppuration is evident, as this will abbreviate materially the incidental discomfort.

Genuine abscess occurs, but much more rarely, in the same situation, and may be ascribed to similar causes. I have observed but few cases; in one of them, however, the abscess had attained the size of a hickory-nut, with large swelling and total occlusion of the nostril. Laudable pus was evacuated by an incision made from within.

L. Wroblewski[1] mentions having seen and operated upon several cases of abscess of the wing of the nose occasioned by the bacillus anthrax benignus.

Erysipelas of the Nose.—Too little attention has been drawn to the fact that so-called idiopathic facial erysipelas quite commonly originates within the nose.

Etiology.—The cause here, as elsewhere, is an infection by the streptococcus erysipelatus, a micro-organism specific to erysipelas, which gains entrance through fissures and excoriations which frequently affect the anterior nares and the cartilaginous septum as well as more rarely the deeper surfaces of the nasal fossæ. Otherwise trifling intranasal operations may furnish the responsible gap, and it is even possible, although not proven, that infection may occur through an unbroken surface. Certain persons are predisposed to infection on the slightest provocation.

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[1] *Archiv für Laryngologie und Rhinologie,* ii [or Zweiter], Band, 1895, S. 297.

Symptoms.—The affection commences like an acute rhinitis of unusual severity. The temperature runs high, there is total occlusion of the nostrils, a profuse excoriating muco-purulent secretion, swelling with erysipelatous redness of the nasal appendage, and later an extension of the erysipelatous dermatitis to a variable distance over the face. In like manner it may extend posteriorly to the naso-pharynx and pharynx or involve the collateral sinuses of the nose—a combination which may present the gravest aspects. On inspection the nasal mucosa appears of a dusky-red color, or it may be covered by a thin milky exudate.

Treatment.—By way of prophylaxis, especially with those who have a history of previous attacks, excoriations and fissures should receive adequate attention to secure prompt healing; all operative measures not strictly necessary should be avoided and others made with thorough antiseptic precautions.

During the attack, for internal administration, the classical remedy for erysipelas, tincture of the chlorid of iron in doses of ten minims and upward, has not been successfully superseded. Locally, for intranasal use, sprays Nos. 1 and 2, formulæ for which are given in the section on acute rhinitis, serve a useful purpose; and as a topical application for the excoriated anterior nares and inflamed skin surfaces, the resorcin mixture detailed in the section on membranous rhinitis can be commended.

Epistaxis—Nose-bleed.—Epistaxis (*epi staxo,* to flow drop by drop) is a hemorrhage from the nose, and varies in degree from a trifling inconvenience to an occurrence which involves grave danger to life.

Etiology, Pathology, and Varieties.—1. *Idiopathic.*—Even when apparently spontaneous, a slight traumatism as in picking the nose or using a handkerchief roughly may be the exciting cause. The bleeding point can be anywhere in the nasal fossæ; but in 90 per cent. of the cases by actual count[1] it is found just within the nostril on the cartilaginous septum. This structure is richly supplied with blood by the anterior artery of the septum, a branch of the superior maxillary, and in copious hemorrhages it may be the artery of the septum itself or some of its twigs which have been opened. The vessels are poorly protected by a thin mucosa, and the spot is much subject to erosion, ulceration, and incrustation. With vessels thus ready to break at any moment, a variety of local and constitutional conditions serve to excite bleeding.

It is a well-known symptom of typhoid, malarial, and pneumonic fevers. It is liable to ensue upon violent exercise or to accompany "rush of blood to the head," from whatever cause, especially in plethoric individuals and in persons affected with passive congestion of the venous system from organic disease of the heart, liver, or kidneys, and during pregnancy. It follows large doses of quinin. It is of course a symptom in ulcerative syphilitic disease, in angioma or "bleeding polypus of the septum," in sarcoma, carcinoma, and other nasal neoplasms. In elderly persons, if recurrent and without other cause, it indicates an ominous degeneration of the vessels. This I have observed in the case of an aged gentleman who had bled profusely in spite of remedies and through the packings for three days, when careful examination by reflected light and with rapid swabbing disclosed a spurting artery of the septum, which was instantly sealed by electro-cauterization.

Vicarious epistaxis is a substitution of nasal hemorrhage for the natural menstrual flow, and occurs at times of acute suppression of the menstrual function or of its difficult establishment about the age of puberty and during the menopause. Doubtless in these cases, also, there is a weakness or erosion of the vessels of the septum, which are unable to withstand the hyperemia of the head which results during perversion of menstruation. The menstrual molimen, including the congestive headache, is relieved by the vicarious epistaxis, which within reasonable limits may be regarded as beneficial rather than detrimental. In one case cited by Fränkel,[1] however, the recurrent nasal flow was so profuse that a fatal termination ensued.

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[1] Chiari and Baumgarten, cited by Bosworth: *Diseases of the Nose and Throat,* vol. i. p. 312.

2. *Traumatic.*—Hemorrhage following fractures and other intranasal accidents, while profuse for a short time, commonly ceases spontaneously. If persistent in spite of packing, it indicates an injury to neighboring parts. Serious bleeding has occasionally resulted from otherwise trifling intranasal operations—*e. g.* removal of spurs from the septum, cauterization of the conchæ, etc., so that means to cope with this contingency should be provided and operations possibly declined on persons from whom a bleeding history is elicited.

Symptoms.—Only the premonitory symptoms of those subject to habitual epistaxis require special mention. Patients complain of vertigo, tinnitus, temporal throbbing, a sense of cerebral pressure and headache, while the cheeks are flushed and the conjunctivæ injected. They are gratified at the bleeding for the relief which it brings.

Diagnosis.—In the absence of actual hemorrhage only a careful search and palpation with a probe, at the risk of exciting bleeding, will disclose the responsible vessels.

Treatment.—Most attacks cease spontaneously inside of half an hour. Simple expedients are: the superficial plugging of the nostril with cotton, pressure of the nasal wing against the septum, the insertion of a finger into the bleeding nostril, ice applied to the side of the nose and held in the mouth, the application of ice in small pieces within the nostrils, ice to the back of the neck and along the spine for its reflex action, the injection of hot water, 120° F., or spraying of hot vaselin into the nose,[2] damming of the blood into the general venous system by constriction of the extremities near the trunk by straps or handkerchiefs, and the administration internally of a mixture of gallic acid, antipyrin, and fluid extract of ergot.

Spraying the nostril by strong astringent solutions of tannic acid, iron, or alum is seldom effective and is objectionable on account of the irritation produced, although the insufflation of powdered matico is generally commended. A better and really effective spray is composed of 4 per cent. solution of cocain in 2 per cent. solution of antipyrin, materials which act as powerful vessel-constrictors. After spraying, a pledget of cotton soaked in peroxid of hydrogen may be introduced well into the nostril, the pressure from the liberated gas in all directions assisting in the formation of a clot.

Really serious cases are prone to resist all of these measures, and then one must either locate the bleeding vessel by rapid swabbing and cauterize it by electricity, chromic acid, or nitrate of silver, named in the order of desirability, or, in case the hemorrhage is too profuse to permit of this procedure, or if for other reasons it cannot be accomplished, one should pack the nasal fossa from front to back with 10 per cent. moist iodoform gauze. This is best done by a slight modification of the plan first proposed by Dr. E. Fletcher Ingals.[3] Two strips of double-thickness gauze, each two feet in length and a full inch in width, are prepared, and near the distal end of each (the end first to be inserted) a strong thread is tied. The first strip is passed through the inferior meatus to the naso-pharynx, fold after fold being pushed in until the lower channel is full. The second strip is passed in like manner well into the middle meatus, and traction is then made on the threads in order firmly to pack the gauze at the rear end, the surplus of gauze in front is cut off and the threads anchored to a padded stick across the nostril. In narrow nostrils there may be room to manipulate but one strip of gauze, and this will then suffice. The point is that the gauze shall be placed as far backward as the naso-pharynx and not merely stuck in front.

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[1] *Ziemssen's Cyclopedia*, vol. iv. p. 152.

[2] Frank M. Rumbold: *The Laryngoscope*, 1896.

[3] E. Fletcher Ingals: *Diseases of the Chest, Throat, and Nasal Cavities*, p. 550

Plugging the posterior nares is a common resort for obstinate epistaxis; but it is liable to provoke inflammation of the middle ear, mastoiditis, and brain complications. I have seen a patient's life placed in jeopardy thereby, and am firmly of the opinion that posterior plugging should be avoided whenever possible. A substitute is found in the above-described method of packing the nose from in front, which will suffice for all cases of strictly nasal hemorrhage.

When, however, the bleeding is from the naso-pharynx itself, as from the removal of "adenoids" or tumors or from operations on the posterior ends of the turbinated bodies, it may be necessary to plug posteriorly.

A wad of iodoform gauze, adapted in size either to fit well into the choana or to fill in part the naso-pharynx, according to the location of the bleeding point, is tied across the middle by strong double silk thread. A soft catheter is passed through the nose, and to its end, picked from the pharynx by forceps, one double thread is tied, and the plug, assisted by a finger around the velum, is thus drawn into the naso-pharynx. These threads are best anchored to a small padded stick across the anterior nares. The other string ends, or one of them, is maintained through the mouth as "a leader" by which to detach the plug. The posterior packing should not remain longer than twenty-four to thirty-six hours without removal. A still less septic plug and one perfectly soft and globular can be prepared, as suggested to me by Dr. Ethan A. Gray, by making it double, as it were, one layer inside the other, the strings being secured around the inner kernel and both layers being covered by thin rubber cloth. Thus I have saved the life of one patient who required packing for a period of five weeks.

NOTE.—Other acute diseases of the nose, primary and secondary syphilis, nasal diphtheria, acute sinusitis of the maxillary, frontal, ethmoid, or sphenoid cavities, and traumatism will be considered in the respective chapters devoted to these conditions as a whole.

CHRONIC AFFECTIONS OF THE NOSE.

By MORRIS J. ASCH, M. D.,

OF NEW YORK CITY.

Chronic hypertrophic rhinitis is a condition of the nasal passages characterized by hypertrophy of the mucous membrane covering the turbinal bodies, by enlargement of the bodies themselves, and by outgrowths from the septum or floor of the nose, which may result from local or constitutional causes.

Etiology.—Chronic hypertrophic rhinitis may follow repeated attacks of acute rhinitis, whether they result from exposure, unhygienic surroundings, or from unhealthy occupations. Printers and workers in chemicals or in trades where dust abounds are particularly liable to the affection, as the particles thus inhaled aggravate, if they do not cause, it; while, in addition, there is the class of workmen exposed to both climatic changes and dust—such as dock-laborers and workers in saw-mills—who are frequent sufferers from the disease.

The condition is not of rapid development, but comes on gradually, attention being called to it by the resulting inconvenience. Some are peculiarly liable by reason of temperament, especially neurotic individuals. Constitutional causes are gout and defective nutrition. Lithemic patients are prone to this affection along with other diseases of the throat and nose met with in gouty subjects. Broken-down constitutions, whether resulting from syphilis, or from defective nutrition following acute disease, or any depressing cause—such as insufficient nourishment and poor surroundings—are easy victims of chronic rhinitis. Leukemia, malaria, and scrofula are all factors in its causation, but although chronic hypertrophic rhinitis occurs mainly in those of poor constitution, yet in persons otherwise healthy an acute catarrh may, under external influences, become chronic and give rise to the pathological changes peculiar to this disease. It has been observed as the result of grip, and is said to occur sometimes after medication with iodin and mercury. Irritation caused by obstruction of the nasal passage, deviation, spurs, or by the "narrow nose" of Störck, may produce chronic hypertrophic rhinitis, or by causing a passive hyperemia aggravate it when resulting from any constitutional cause.

Pathology.—The prominent condition in chronic hypertrophic rhinitis is hypertrophy of the turbinal bodies and of the mucous membrane covering them. This membrane is richly supplied with blood-vessels, and especially veins. It is elastic, and therefore erectile, and forms with the submucous layer true corpora cavernosa, which fill or collapse according as they are supplied with or emptied of blood. When the walls of the venous canals become thickened through hypertrophy and lose their elasticity, the enlargement becomes permanent. Wingrave[1] says that the condition is not a mere hypertrophy of the structure, but consists of a true degeneration and infiltration of the walls of these vascular spaces; the walls gradually losing their power of active recoil, the vessels become more and more distended and a permanent enlargement, which is in fact a varix, ensues.

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[1] *Journ. of Laryngol.*, 1894.

In the first stage of the disease the turbinal borders are greatly enlarged and the mucous covering soft and sodden, yielding without elasticity to the pressure of a probe. There is a decided cellular infiltration of the epithelium and subepithelial tissue, especially about the glands and vessels.

The epithelial cells are increased in number, the upper layers becoming flattened or cuboidal, while the ciliated cells are preserved only to a slight extent. The venous channels are distended in the deeper portions. After a time the swelling of the mucous membrane becomes more marked and there is a change from diffuse infiltration to a circumscribed thickening. The appearance of the parts now indicates a fibrous change, and the surface of the turbinals may become irregular from want of uniformity in the swelling.

The inferior turbinal is the part usually enlarged, especially in its posterior extremity. The anterior extremity is also frequently affected, while it is very rare to find enlargement only of the middle portions. These circumscribed infiltrations sometimes appear as true growths of varying color—sometimes purple, indicating great vascularity—sometimes whitish because of preponderating connective tissue and thickening of the epithelium.

The surface is frequently smooth, as in ordinary nasal mucous membrane; at other times papillary hyperplasia is so strongly developed as to give rise to a mulberry-like appearance. Not infrequently myxomatous changes occur, especially at the anterior extremity of the inferior turbinals, while papillary degeneration is most frequently observed in the posterior hypertrophies. Later on we find cartilaginous and bony outgrowth from the septum and floor of the nose, which by obstruction to respiration and by pressure act injuriously.

Posteriorly the ends of the inferior turbinals, when enlarged, are usually dark red, although sometimes white in color, with a surface varying in appearance, sometimes smooth and rounded, but often rough, irregular, and mulberry-like, and occasionally they protrude into the naso-pharynx so as to interfere with the functions of the Eustachian tubes. The middle turbinals are also the seat of these hypertrophies, as is also the floor of the nose and the sides of the septum. The pharyngeal tonsil will often be found enlarged.

Later in the disease all these morbid conditions become more marked. The hypertrophied tissue becomes more dense; and in addition to the turbinal enlargements we have ecchondroses from the septum and exostoses from the anterior nasal spine of the superior maxillary bone.

The middle turbinals show a hard, resisting surface, filling the whole meatus, tightly pressed against the septum; although frequently the mucous membrane covering them becomes the seat of a myxomatous degeneration, giving rise to masses which, from their soft and gelatinous appearance, may be mistaken for polypi.

On the posterior portion of the septum there are thick cushion-like swellings of the same color as the surrounding mucous membrane, and from the floor of the nose and from the posterior extremity of the inferior turbinals appear firm elastic hypertrophies, usually light in color, either smooth or papillated, although when their surface is rough they are frequently of a darker hue. When the hypertrophies appear on the septum they are often symmetrical in both nostrils. The vault of the pharynx and the larynx are usually involved in the last stage of the affection.

Symptoms.—In the first stage of the disease the symptoms are those of ordinary catarrh. The secretion in most cases is thick and scanty, containing large quantities of mucin. It is muco-purulent, and on account of its toughness dries most readily and appears as odorless yellow and yellowish-green crusts on the walls of the nasal cavity and at its entrance. In rare cases the secretion is free, thin, and serous, as in acute catarrh.

The principal symptom, however, and the one most complained of, is that of more or less nasal obstruction, the degree varying with the size of the swelling and the character and quantity of the secretion. Accompanying this is the discomfort produced by the accumulation of secretion in the naso-pharynx, where it either dries and is hawked out with difficulty, or is expectorated or swallowed. There is fulness of the head, especially in the frontal region and over the eyes, frequently followed by severe migraine; in addition there is a sense of dryness of the tongue and throat, which is almost continuous. The secretion of mucus in the throat is abundant in the mornings, and frequently the patient vomits in the effort to be rid of it.

A common fact noticed is the filling of the hypertrophied turbinal with blood by gravitation. It frequently happens that when a patient lies on the side the corresponding hypertrophied part will be distended, while bending the head forward will cause occlusion of both sides; a reversal of position will favor the return of the blood and the restoration of function of the part.

Mouth-breathing, with all its attendant evils, is a prominent feature of the disease, and a nasal twang to the voice is a common accompaniment. The sense of smell is affected, and frequently complete anosmia results, in which case the sense of taste is also impaired. As a result of the attempt to clear the nose of adherent secretion, small hemorrhages occur; and the frequent use of the handkerchief often gives rise to painful eczemas at the nasal orifices.

When the middle turbinals are involved, frequent and severe frontal headaches occur, the result of pressure on the nasal branch of the fifth pair. Pharyngitis, laryngitis, and bronchitis are also present as the result of the nasal lesion. Most common, however, as the result of the obstruction of the nasal passage we find affections of the ear. Chronic catarrh of the middle ear and of the Eustachian tubes are frequent sequelæ, while tinnitus and vertigo also occur.

The eyes also suffer as a result of hypertrophic catarrh. Conjunctivitis is not uncommon. In asthenopia with headache, where correction of refraction has not cured, the cause has often been found to be in an enlarged middle turbinal body, the removal of which relieved all the symptoms.

Among other symptoms due to hypertrophic rhinitis are reflex neuroses; not very common, it is true, but still sufficiently so to warrant our examining the nasal cavities for their probable cause. Hay fever is often relieved by the removal of hypertrophied tissue on the inferior or middle turbinated bodies. Schech speaks of a nervous catarrh of similar origin where a thin, clear, and extremely profuse secretion makes its appearance suddenly and at intervals, associated with diminution or loss of smell, obstruction of the nose, and violent sneezing. These attacks last several hours, and are most frequent at the menstrual periods. Vaso-motor disturbances are not uncommon. Reddening and swelling of the face and conjunctiva often appear on the slightest irritation, and disappear as suddenly, leaving no trace.

Asthma is the most common of the reflex disturbances in hypertrophic rhinitis. It usually comes on during sleep, and may be, as suggested by Schech, the direct consequence of irritation of the vagus—the result of diseased nasal mucous membrane. Too much stress, he thinks, has been laid on the part the spongy tissue plays in the origin of nocturnal asthma, though it certainly is a factor in its production.

Other reflex symptoms that have been observed are aphonia, laryngeal spasm, and supra-orbital and facial neuralgias. Spasmodic cough is not infrequently found to be the result of intranasal pressure, and I have often relieved a cough of long standing by removal of the hypertrophied turbinal body.

It has been my experience that asthma and hay fever, when they can be referred to the nose, depend upon the hypertrophy of the inferior turbinals; while neuralgias and headaches were as invariably the result of pressure of the middle turbinal on the septum. Epileptic attacks and vertigo may be also included among the affections induced by this disease. It will be seen, then, that the results of a diseased condition of the intranasal regions may produce complications far beyond the local trouble in sight; and bearing this in mind, the ophthalmic or aural surgeon of to-day can scarcely be said to have made a thorough examination of a patient when the nasal cavities have not been included. It is very certain that the presence of spurs, hypertrophies, and deviations play a very considerable part in the production of catarrhal troubles both of the eye and ear. Affection of the lachrymal ducts, keratitis, purulent dacryocystitis, and impaired vision, together with all the distressing symptoms that belong to mouth-breathing, as anxiety at night, disturbed sleep, dryness of the pharynx, larynx, and trachea, with sometimes resulting inflammation, disordered digestion, and mental dulness, all these may follow the condition of the nostrils.

Externally we may have eczema of the nostrils, the result of irritation, sycosis from the constant maceration of the upper lip, pustules, erysipelas, and redness at the tip of the nose from engorgement, the swollen spongy tissue preventing a return of the blood.

When we examine a patient we find appearances varying with the stage of the disease. In its first stage the nostril is more or less occluded anteriorly by an enlarged inferior turbinal body, which is either red or normal in color. The enlargement is spongy and elastic, and, although usually occupying the anterior extremity of the inferior turbinal, it may also be found to involve the middle, causing it to press against the septum. Hypertrophy of the inferior turbinal can be temporarily reduced by pressure with a flat probe, the enlarged sinuses emptying, but immediately filling again. This rapid resumption of shape tends to distinguish the hypertrophic from the chronic form of rhinitis where pressure by a probe simply displaces a certain amount of infiltration.

Cocain in from 2 to 5 per cent. solution has the same effect in rapidly contracting the spongy tissue, but does not entirely dissipate its tumefaction. Those swellings that disappear entirely under cocain belong to simple chronic rhinitis, and not to the hypertrophic variety.

Diagnosis.—There should be no difficulty in making a diagnosis of this affection. The only disease with which it might be confused is nasal polypus, but the use of the sound and of cocain should easily differentiate the two conditions. An important point when making the diagnosis is to ascertain whether the hypertrophy is primary or due to a constitutional cause, such as syphilis, as this has an important bearing on the prognosis and treatment.

The **prognosis** is good if there are no complications.

Treatment.—In the first stage of the disease the treatment should be mild, attention paid to hygienic surroundings, the nasal passage protected from vitiated atmosphere, and in some cases removal to another climate recommended. Excess of any kind must be prohibited, and any constitutional vice which might be a factor in producing the disease is to be sought for and eradicated, if possible.

It is astonishing how much good can be done in the first stage of the disease simply by attention to the ordinary laws of health. The local treatment must be unirritating. At first only the simplest remedies should be used, by means of the spray or irrigation, by the nasal douche, the nasal douche-cup, and insufflation of appropriate solutions through the anterior nasal passage into the pharynx. The spray, many formulæ for which are in constant use, should be applied, if the application be made by the patient himself, by means of the hand-ball atomizer such as is usually sold in the shops, provided with a blunt nozzle to prevent injury to the nostril. When the spray is used by the physician in his office, compressed air is usually the motive power, contained in a cylinder filled by means of a hand-pump, although the pumping may be done by means of water-power or an electric motor.[1]

While I am accustomed to use the spray in the treatment of chronic rhinitis, I do not look upon it as a curative measure, except in very slight and recent cases, when the clearing away of secretion gives the affected mucous membrane an opportunity to regain its normal condition. I do find the spray very useful, however, when the pressure is raised to forty pounds, to wash away crusts from the posterior nares and especially from the vault of the pharynx—so much so that I have never had occasion to use a posterior nasal syringe for the purpose. In atrophic cases of long standing, where the secretion is very adherent, I have sometimes made use of dry cotton, wrapped on an applicator bent at a right angle, to remove it, but usually the force of the spray is sufficient. If the force of the spray is increased gradually there is no discomfort, nor is any injury inflicted either in the nostrils or the Eustachian tube. A very slight stain of blood may follow the application, but there is no epistaxis nor any consequence to alarm the patient.

The solution used in the atomizer varies rather with the fancy of the operator than with the exigency of the case, for any detergent alkaline fluid may be used. Normal salt solution, boric acid gr. x to ℥j aq., Dobell's solution with the addition of listerin, or a combination with thymol-menthol and eucalyptol as in Seiler's tablets, are all in frequent use. Sajous recommends a solution of bicarbonate of soda and borax, *āā* gr. viij; ext. fluid. pini canadensis, ♏ xv; glycerin, ʒij; aquæ ad, ℥iv. Alum 1 or 2 grains to aq. ʒj is used; but in common with the salts of zinc and lead is said to produce anosmia.

Of more importance than sprays in their curative properties are applications made locally to the affected membrane. Nitrate of silver is probably the most efficient of all the simple applications; it can be applied in strengths of two to ten grains to the ounce, but should never exceed this. It must be used with regularity, as an occasional application of it is of no advantage.

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[1] In my clinic at the New York Eye and Ear Infirmary, where sprays are largely used as cleansers in all cases of nasal disease, every table at which a surgeon is seated is supplied with a rubber tube which connects with an atomizer by means of a bayonet-joint. The compressed air is forced into a large cylinder in the basement of the institution by means of an air-compressing engine driven by steam, which is in constant action during the service of the clinic. A safety-valve on the cylinder, usually set at forty pounds, prevents the pressure ever rising beyond this point. The cylinder connects by means of an iron tube with the clinic-room, where it is distributed to each of the tables at which patients are treated. In consequence of the distance traversed by the tubes some of the pressure is lost before reaching the operator, so that the spray is usually made at a pressure of about thirty pounds, which is the strength I find most convenient, but which can be still further modified by the cut-off regulating the spray.

Störck objects to its use in consequence of the stains it sometimes produces on the exterior of the nose, and of the disagreeable sensation resulting. It should never be used as a spray, but applied carefully with a piece of lint wound on the extremity of a fine nasal applicator there should be no external mark, and any disagreeable sensation resulting can easily be relieved by the snuffing up of a little salt water. There is a possibility that a pocket handkerchief used just after the application may be stained. This can be guarded against by giving the patient a Japanese paper handkerchief to use for a little time after the treatment. Iodin and glycerin made according to the following formula: Iodini, gr. vj; iodidi potassii., gr. xij; glycerinæ, aquæ, *āā* ℥j, is an application of great value.

Krieg recommends soziodal of soda and menthol in lanolin and vaselin: Sodii soziodal, menthol, *āā* gr. xv; lanolin, ℥ss; vaselin, ℥j, to be used as an ointment. Resorcin in 10 per cent. solution has been recommended as an efficient application, and a host of other astringent and alterative substances which too often fail to accomplish the good result promised. Powders are used by some writers, insufflated into the nostril, but they more frequently clog the passages and produce irritation than bring relief. They are to be used, if at all, when the discharge is profuse. Camphor, tannin, bismuth, iodoform, subnitrate of bismuth, and borax, all have been used in this way, either snuffed up into the nose or blown in by an insufflator. I am inclined to believe that more harm than good is produced by this method of nasal medication, except when there happens to be an ulcerated surface, which is not likely to occur in the affection we are discussing.

Occasionally in hypertrophic rhinitis, when it happens that the obstruction is located at the anterior extremity of the inferior turbinal, and is soft, the patient suffers great inconvenience at night from his inability to breathe through the nostrils. In such cases I have found that great relief can be given by the introduction of a vulcanized rubber nasal tube, such as I use after the operation for deviated septum, which should be just large enough to remain in the nostril when inserted. This gives rise to no irritation, and enables the patient to sleep in comfort. It is not intended to bring about a cure of the hypertrophy by pressure, but merely to serve as a palliative during the temporary nocturnal swelling that occurs so frequently in this disease.

When we find the hypertrophic process to be so far advanced that ordinary treatment is of no avail, we must have recourse to measures calculated to cure by removing a sufficient quantity of the redundant tissue, and by means of the resulting cicatrix insure its permanent reduction. To do this we use caustics, acids, the galvano-cautery, the snare, either with the cold wire or galvano-caustic loop, and, in case of posterior enlargement, curettes or ring-knives. The caustic acids are used only when the hypertrophy is anterior and is soft. Those in most general use are the chromic and monochloracetic acids. When the use of an acid has been decided on, the nostril is well washed out with a modified Dobell's solution, dried with absorbent cotton, and if the patient is sensitive it is anesthetized with a solution of cocain varying from 2 to 8 per cent. in strength, according to his susceptibility. It frequently happens that the weaker solution is quite sufficient to deaden sensation, and it is certainly safer to use it in cases where only a brief time will be taken up in any operative proceeding, in view of the toxic effects not infrequently observed after its intranasal use.

The cocain should be applied by means of a pledget of absorbent cotton, allowed to remain in contact with the affected turbinal for about five minutes; it is then removed and the part dried. The chromic acid is applied by means of a fine probe wrapped with cotton-wool, which is moistened and dipped in the acid, so as to permit but a small quantity to adhere. This is pressed firmly against the turbinal for a few seconds, taking care not to affect too large a surface. The acid remaining is neutralized by an alkaline solution. After a little while cicatrization with contraction follows, but the process must be repeated several times before any appreciable improvement is noticed. An interval of a week at least should intervene before an application of the acid is repeated.

The acetic acid is to be used with the same precaution and in the same manner as the chromic acid, except that an aluminum applicator with a pocket to hold the dry acid is used. In the advanced stage of anterior hypertrophy, when the fibrous change has become marked, the more powerful agency of the galvano-cautery must be invoked. The various forms of batteries and the methods of heating the cautery-knife having been mentioned elsewhere, it only remains to describe the technique of its application. The nostril having been anesthetized with cocain, the margins of the nostril are protected by a speculum—Duplay's or a large aural speculum answering the purpose very well—otherwise they are likely to be burned. The electrode should not be large, a small knife answering every purpose. It should be heated to a cherry red, and a linear incision of the required length made through the mucous membrane. It is very important that the knife should be heated to the proper temperature; a lower degree of heat than the cherry red will give rise to severe pain, while with a white heat profuse hemorrhage may ensue. Care must also be taken not to burn the septum, otherwise the resulting inflammation may cause synechiæ to form. After the cauterization the parts are to be sprayed with Dobell's solution or with liquid vaselin, repeated daily for a week, at which time another cauterization may be performed. Several applications of the galvano-cautery are usually required to produce any appreciable result.

The resulting inflammation is slight, and usually there are no uncomfortable sequences if the application has been carefully and judiciously made; yet there are cases on record where serious results have followed either a too extended and deep cauterization or when it had been made too freely to the posterior extremity of the turbinal; for it must be laid down as an axiom that this procedure can only be safely applied to the anterior hypertrophies. Störck[1] protests strongly against the indiscriminate use of the galvano-cautery, while believing it to be the best means of application. He complains that it is used too frequently, and especially by inexperienced men who do not know when and how galvano-cautery is to be done, who burn away the mucous membrane in all directions, from which eventual recovery never occurs. On the contrary, there results a still worse condition of the mucous membrane, which becoming adherent to the opposite side, causes synechiæ and often complete occlusion. Where a patient has only had chronic nasal catarrh, he now has an occlusion of his nose that makes his life unhappy. No application of the galvano-cautery should be made except to parts clearly in the field of vision. He is so strongly impressed with the abuse of this method of treatment that he declares that if it were possible to forbid the use of the remedy by police regulation, he would be the first who would vote for it.

If the galvano-cautery is ever applied to the posterior extremity of the inferior turbinal body, it should only be by means of a guarded electrode in the hands of an experienced operator; and even then there is danger of inflammation of the Eustachian tube with resulting purulent otitis. Erysipelas, conjunctivitis, meningitis, and septicemia are complications that have followed too bold a use of the galvano-cautery.

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[1] *Diseases of Nose, Throat, and Larynx,* Vienna, 1895.

Electrolysis has been recommended by some authors; but the uncertainty of its results and the slowness of the method have prevented its being used extensively.

When the hypertrophied tissues are too extensive to be removed by caustics, or when they are soft and pendulous or circumscribed, we resort to surgical means for their removal—forceps, the ring-knife, or the snare being used.

In this country the ring-knife is rarely employed, although in England Wingrave and in Germany Störck approve its use. Wingrave, in a communication made to the British Medical Association at Bristol in 1894, reports over 200 cases of turbinal varix treated in this way, and as the result recommends the use of the ring-knife of Carmalt Jones.

In hypertrophies of the middle turbinal body it not infrequently happens that the part cannot be satisfactorily encircled by the wire-loop; in such cases strong forceps, such as are figured elsewhere, are used to remove the superfluous tissue and relieve the obstruction. But by far the most satisfactory method for the removal of intranasal growth is the cold wire snare, used in the instrument devised by the late Dr. Jarvis, or one of its many modifications. This method is preferable for several reasons. It is easily applied and can be used in the narrow passages of the nose, which would be impassable to anything larger than the wire; the inflammatory reaction which follows its use is less intense and less lasting than that following the cautery; there is less danger of infection, and if proper care be taken there is less danger of hemorrhage; but in order to insure this it is necessary that the section be made slowly, from twenty minutes to half an hour being occupied in the removal of a large hypertrophy. If this precaution is not taken serious hemorrhage may result, especially when cocain has been used as a local anesthetic, for this not only prevents sensation, but masks the bleeding by the temporary contraction it produces. While it may be said that cocain should be used in all cases, still it has the disadvantage of rendering the operation much more difficult in those cases where the enlargement is principally of the soft tissue, especially in the posterior portion of the inferior turbinals, for it so contracts the tissues that it is almost impossible to encircle them in the loop.

I am in the habit in operating by this method of using the Jarvis snare, with a modification in the manner of fastening the wire. In place of the pins around which the wire is wound, in order to hold it, on the original instrument, there is at the end of the movable cannula a steel clamp with its inner surface finely grooved, and which is governed by a screw. The ends of the loop of wire pass between the surfaces of the clamp and are retained in position by a screw working on a male screw passing through the lower clamp. This arrangement has the great advantage that a small loop can be passed into the narrowed nostril and enlarged at the will of the operator. When the loop has been sufficiently enlarged—and sometimes it is necessary to make it larger than the turbinal in order to permit of its encircling the projecting extremity—it is drawn upon until it is felt that it has the hypertrophy in its grasp. The clamp is then tightened and the loop gradually drawn in by the screw provided for that purpose.

The advantage of fastening the wire by means of the clamp over pins or any method that fixes the ends of the wire is, that if by any chance the cannula should have been screwed down to its fullest extent without cutting through the growth, by simply loosening the clamp the cannula can be run along the wire to its original position, and, the clamp being refastened, the tightening of the loop is begun anew. This maneuver is very useful and has served me more than once in difficult cases. When the anterior extremity of the inferior turbinal is to be removed, cocain may be used if the patient is unwilling to bear the slight amount of suffering entailed by the operation, although it renders the operation more difficult. As before remarked, the loop must be tightened very gradually, or profuse and even serious hemorrhage may occur.

When the posterior extremity of the turbinal is to be removed the operation becomes much more difficult. The location of the swelling makes it more difficult to grasp and the prolonged manipulation is harder to bear. It is not possible to give any detailed instruction as to the method of operating. Each operator, as a rule, has a method of his own, being governed by his own peculiar facility. Some, by a special knack of giving direction to the wire, are able to easily encircle the mass. Others put the loop which has been passed through the nostril in place by means of a finger introduced into the naso-pharynx, while others guide it into position by means of the rhinoscopic mirror. Whatever method is used, two objects must be carefully looked out for—viz., prevention of hemorrhage and avoidance of infection. To insure this it is necessary, after the operation has been performed in the cautious manner advised above, to use antiseptics. Aristol or dermatol blown into the nostril answers the purpose very well. A pledget of corrosive-sublimate gauze is then inserted and removed in twenty-four hours, after which it need not be replaced; but the wound must be sprayed with a modified Dobell's solution, consisting of the ordinary Dobell's with the addition of ten grains each of thymol, eucalyptol, and menthol to the pint, and afterward insufflated with the antiseptic powder every day until cicatrization is complete.

When the operation has been performed too quickly and hemorrhage follows, cold or astringents should be applied, or the nose may be sprayed with peroxid of hydrogen or a solution of antipyrin. If these means fail to stay the bleeding, it will be necessary to plug the nostril. This I do in the following manner: I take a wad of antiseptic cotton the size of a two-drachm vial or larger, according to the size of the nostril, and tie a silk ligature to its center; this is forced into the nostril so as to close its posterior opening, leaving the end of the ligature projecting beyond the nostril. On top of this, antiseptic cotton is packed until the nostril is filled and the hemorrhage checked. The end of the ligature is then cut to the proper length and fastened to the cheek alongside of the ala of the nose with a bit of adhesive plaster. If this fails to prove effective, the packing must be taken out and replaced in the same manner. This method has always stood me in good stead, and I have never had to use any other means to restrain bleeding, even when very alarming. The packing must be left in place forty-eight hours. If removed before that time the bleeding is likely to recur, and occasionally even then, in which case it must be replaced as before. If, however, there should be no return of bleeding, the nostril should be cleansed with a *very gentle* spray, an antiseptic powder insufflated, and the case treated as where there has been no complication.

When instead of the cold wire the galvanic loop is used, the same precaution as to slow section and antiseptics after the operation must be observed. If the wire is heated to a white heat and the section made rapidly, hemorrhage will inevitably ensue. It sometimes happens in a narrow nose that the portion of the turbinal removed by the snare is too large to pass the external orifice; in such cases it falls backward into the pharynx and is expectorated through the mouth, or, as occasionally occurs, is swallowed by the astonished patient.

In addition to hypertrophy of the extremities of the inferior turbinal, other enlargements demand treatment: myxomatous degeneration of the mucous membrane of the middle turbinal, hypertrophies of the floor of the nose, and thickening of the posterior portion of the septum. Each one of these must be treated according to the nature of the hypertrophy and its location. The polypoid thickening of the middle turbinal is best removed by snare, although in careful hands the contact of the galvano-cautery will accomplish a good result. For hypertrophy of the floor of the nose when cartilaginous or osseous the electro-trephine is best suited; when soft the galvano-cautery must be used. The swellings on the posterior portion of the septum are more difficult to manage. They should only be subjected to surgical interference when they add to the obstruction of the posterior nasal passage. They are usually soft, and under the guidance of the rhinoscope can be touched with the galvano-cautery. There is not, to my mind, the same risk in its use here as when applied to the posterior extremity of the inferior turbinal, for the orifice of the Eustachian tube is less likely to be injured and there are no important structures in the immediate vicinity. When the nasal passage permits, a small electro-trephine may be introduced and the projection shaved away: but it is only rarely that this can be done satisfactorily.

Before using surgical measures of any kind, however, it is well to give a trial to local applications of the iodin and iodid of potash solution, which in some comparatively recent cases will cause the hypertrophy to disappear.

Some writers divide the treatment of chronic hypertrophic rhinitis according to the early or late stage of the disease, but in whatever stage the disease comes under treatment, the rule is always to use the mildest method that will accomplish the desired result. Only when local applications fail to reduce the enlarged structure should recourse be had to surgical measures, and then only that surgical method should be employed that will do least harm to the surrounding healthy tissue. Cases have far too frequently occurred where the discomfort of the patient resulting from too radical an operation has brought about annoyance exceeding that of the original disease.

Attention must be paid to proper hygienic measures. The same rules are to be observed as in patients suffering from simple chronic rhinitis. Exercise in the open air, bathing and friction of the skin are particularly to be insisted upon. The whole body should be vigorously rubbed every morning on rising with a horse-hair glove or a dry coarse towel and then exposed to the air for some minutes. Cold plunge-baths are not to be advised, but the patients, if not too susceptible, may use cold sponging.

Local hygienic measures consist in removing the patient from an irritating or dust-laden atmosphere, or in cases where a person's trade or profession makes this impossible, a respirator may be worn or the irritating air be prevented from entering the nostril by a thin wad of Angora wool inserted just within the vestibule, as proposed by Dr. J. Solis-Cohen.[1]

The constitutional measures to be employed depend on the condition producing the disease. When the gouty diathesis is prominent, suitable means must be taken to antagonize it. So with syphilis, malaria, anemia, neurasthenia, etc. No specific medication is indicated, only such remedies should be administered as are called for by the condition of each patient.

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[1] *Diseases of the Throat and Nose.*

DEVIATION OF THE NASAL SEPTUM.

Deviation of the nasal septum is one of the most prominent causes of chronic disease of the nose, carrying with it maladies of the accessory sinuses, troubles of audition, and various nervous affections classed as reflex, such as asthma, chorea, and headaches. It is not to be confounded with the simple thickenings of the mucous membrane over the vomer and cartilaginous septum which frequently cause stenosis; but consists in a decided bending of the triangular cartilage of the nose to either side, nearly always accompanied by a corresponding alteration in the shape of the vomer and invariably by a redundant amount of material in the cartilage itself, which may be so great in some cases as entirely to occlude the nostril, and by interfering with proper drainage and respiration cause the varied inconveniences which call attention to the malformation. The character of the deformity varies in different cases. There are five varieties of deviation to be observed. There may be—

First. Simple deviation of the cartilaginous septum to either side where there is a simple rounded convexity on one side and concavity on the other, with little or no thickening of the mucous membrane.

Second. Deviation of the cartilaginous septum in the same manner, accompanied by corresponding deviation of the anterior portion of the vomer.

Third. Sigmoid deviation where the cartilage is bent in an "S" shape, with a convexity at its superior and inferior portion in one nostril, and convex at the middle portion in the other, making a sharp longitudinal ridge running posteriorly.

Fourth. The deviation may be angular.

Fifth. It may be vertical, in which case the cartilaginous septum is alone involved. In nearly all cases, though not invariably, the deviation is toward the left. Sex seems to have some influence, as more cases are observed in males than in females.

Etiology.—There are several causes of deviation of the septum. Delavan[1] divides them into predisposing and exciting; he considers diathesis and racial characteristics as the most important of the predisposing causes, and believes that persons suffering from the strumous, syphilitic, tubercular, or rachitic diatheses are most liable. This view of its diathetic origin is hardly borne out in the cases that have fallen under my observation, where the majority of them seemed to be free from any constitutional taint. As regards the influence of race, deviated septa are much more common among the civilized than the savage races. This is attributed to the greater admixture of types occurring in civilized countries as the result of immigration, while the rarer occurrence of deviation among the less civilized races is due to the purity of the race. Races with aquiline noses are more apt to have deviated septa, except the American Indians, who are singularly free from the deformity.

Exciting causes may be imperfect or unequal development of the plate of the vomer, the result of malnutrition or inflammation.

Obstruction of the anterior part of one naris is considered by Collier[2] to be a factor in the production of the deformity by producing rarefaction posteriorly, the resulting pressure causing deviation on that side.

Deflections of the septum are usually observed in adults or adolescents, but cases have been observed in my clinic at the New York Eye and Ear Infirmary whose age did not exceed four years. Traumatism is an occasional cause of deflection, but the cases due to this cause, unaccompanied by fracture of the nasal bones, are so rare that it can hardly be considered as an important factor in the causation of the deformity. A very important cause is the defective development of the bony septum. The vomer consists in its early stages of two laminæ enclosing a plate of cartilage which forms the cartilaginous septum; these laminæ do not coalesce until after puberty, consequently unequal development of one of these laminæ would push the other out of line and cause a corresponding deviation. This unequal development in different directions gives rise to the various forms of deviation observed.

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[1] *Trans. Amer. Laryng. Assn.*, 1887.

[2] *Journ. of Laryng. and Rhinology*, vol. v. p. 91.

Local malnutrition is, according to Ingals,[1] an important factor in the production of deflection. Jarvis regards the high-arched palate as a cause of deflection, the septum being crowded upward by the hard palate until it yields to the pressure brought to bear on it, the cause of the palatal deformity being explained on the theory of atmospheric pressure, occlusion of the nasal passages creating in them through inspiration a partial vacuum, disturbing the equilibrium of pressure upon the upper and lower aspects of the roof of the mouth. This inequality of atmospheric pressure, exerted during infancy and early growth of the child, gives rise to the permanent deformity of the hard palate, thus interfering with the normal development of the septum, in turn further disturbed by the disturbance of respiration.

The bony ridges found along the line of suture of the septum with the superior maxillary bone are due probably to primary injury, aggravated afterward by hypernutrition. They can scarcely be classed as deviations, though considered so by many authors who have treated of the subject.

Roe,[2] in a paper on the etiology of deviations of the nasal septum, considers that heredity plays an important part as a predisposing cause, not only by the dyscrasias which may be transmitted, but also by the blending of different races, bringing about an infinite variation in the conformation of the osseous and cartilaginous structures; and that trauma, nasal obstruction, and unequal growth of the component parts of the vomer are the most frequent exciting causes.

Symptoms.—Attention is usually called to the existence of the deformity by the functional troubles which give rise in many cases to serious inconvenience. Obstructed respiration is the most noticeable annoyance, thereby causing mouth-breathing with its accompanying inconveniences, nasal voice and post-nasal catarrh. Mackenzie[3] reports a case where the most troublesome symptom was epistaxis caused by erosion of the outer wall of the nose; but the great majority of patients who have come under my observation have complained of the impeded respiration caused by the obstructed nostril, and have sought relief on this account only.

Severe headaches are often caused by a deviated septum, when a deviation in the upper portion of the septum presses on the middle turbinal body, while asthma and affections of the larynx are not infrequent results. A very common symptom is the nasal voice which is nearly always present in well-marked cases. Cases have been seen by me where chronic headache and asthma were present and were relieved on restoration of the respiratory function of the occluded side. When there is considerable deviation the nose is often twisted to one side, but frequently there is only a slight twist of the tip.

Diagnosis.—The diagnosis of the affection is very easy and can be made even on a very superficial observation. Examining the nostrils anteriorly there is found a bulging of the cartilaginous septum into one side, either entirely or partially occluding it. On the opposite side there is a corresponding enlargement of the nasal cavity, frequently filled by a hypertrophied inferior turbinal body. This is so frequent a condition as almost to be constant. The septum itself is rarely increased in thickness when there is deviation; but it often happens that the septum is thickened to such a degree as to cause obstruction, and unless attention has been called to the condition an error in diagnosis might easily be made. Inexperienced observers have mistaken a deviated septum for a myxoma, which should easily be recognized by its mobility, softness, and pale color. Whatever the form of the deviation, the symptoms are the same; they do not differ whether it be sigmoid, vertical, or a simple curved bending. It is not always possible to ascertain by anterior rhinoscopy whether the cartilaginous deviation is continuous with the bony septum; but if the case permits it, posterior rhinoscopy will reveal its existence, if present.

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[1] *Trans. Amer. Laryng. Assn.*, 1882.

[2] *Trans. Amer. Laryng. Assn.*, 1896.

[3] *Diseases of Throat and Nose*, vol. ii. p. 426.

Practically, the coexistent deformity of the bony septum is of no importance, as the correction of the deformity in the cartilaginous portion will almost invariably restore the function of the nose and permit respiration.

Treatment.—Treatment of deviation of the septum is necessarily surgical; all palliative methods are useless, and simply waste the time of the surgeon and exhaust the patience of the invalid. Pressure, digital and instrumental, the use of metallic sounds, or of laminaria for gradual dilatation, are methods which have all been tried and relinquished—the irritation caused by them more than equalling the discomfort produced by the original trouble, while the results are negative.

Several methods have been devised for the correction of the deformity; they vary largely in method and principle, and most of them, because complicated in their technique, have given way to simpler processes.

Dieffenbach, as early as 1845, excised the projecting portion of the deflected cartilage with a knife. Huyler dissected up the mucous membrane from the prominent portion of the septum and removed the redundant cartilage with scissors. Adams, in 1875, proposed to correct the deformity by means of the forceps which are known by his name. He fractured the septum with them, retaining it in its proper place afterward by means of ivory plugs or steel plates adjusted by screws.

Ingals proposed an oblique incision through the convexity of the septum, then, having detached the mucous membrane from the cartilage, he excised a V-shaped piece, bringing the parts together by suture and holding them in place by tampons.

Glasgow, in 1881, presented to the American Laryngological Association the method of Steele, which consists in making a stellate incision over the deviation, through the mucous membrane and cartilage; the septum is then crowded back and an ivory plug inserted, which is worn until the cure is complete.

Jarvis, in 1882, proposed the removal of the projecting portion of the cartilage by means of the needle and snare. He pierces the base of the projection with a transfixion-needle until the point appears, a wire loop of a snare is passed over the projecting point, and the engaged portion is severed.

Roberts of Philadelphia uses pins to hold the septum in place after having corrected the deformity. He makes an incision through the septum along the line of convexity; then pushes a long steel pin through the septal cartilage of the normal nostril a short distance above and in front of the incision. Pressing the end of the nose and septum into proper position, he brings the head of the pin close to the anterior part of the septum, causing the part lying in the obstructed nostril to lie across the incision and adapt itself lengthwise along the surface of the septum beyond. The pin is then pushed in to the head and its point deeply embedded in the soft tissues of the septum and upper and posterior part of the obstructed nostril.

Roe, in 1891, devised a fenestrated forceps for rectifying the deformity by pressure after having partially incised the cartilage by means of a modified Steele's forceps with which he cuts through the cartilage and mucous membrane of one side only, leaving the mucous membrane of the other side intact. As the incision must be made over the convex portion of the deviation, it necessarily follows that in aggravated cases it will not be possible to introduce the instrument in order to make the incision.

Watson of Philadelphia proposed a bevelled incision along the crest of the deviation through the cartilage, but not through the mucous membrane of the opposite side; the upper portion is then pressed over toward the other side until it hooks itself onto the lower and is thus held in place. The projecting base that is left can then, or after healing, be removed by the saw.

The method that I prefer and with which I have had the most satisfactory results is one presented by me at the meeting of the American Laryngological Association in 1890. It has been performed by myself and colleagues very many times and has been uniformly successful. The principle is the same as that of other operations—viz., the destroying of the resiliency of the septum, but the technique of the operation differs, and in that lies the secret of its success. The operation has been slightly modified by me since I proposed it, but in its important features it remains the same. It consists in making a crucial incision through the cartilaginous septum, breaking down by the finger or forceps the bases of the segment thus formed, and the insertion of a hollow splint. The rapidity and simplicity of the operation commend it, for it can be completed in a very few minutes, even in complicated cases. The instruments I employ in the operation are:

First. A pair of strong cartilage-scissors, one blade blunt and narrow for introduction into the obstructed nostril, the other, the cutting blade, of a curved wedge-shape (Fig. 570), the shanks of both blades being curved outward so as to admit of closing without interfering with the column; the handles being of steel and curved like those of a dental forceps. I sometimes use a scissors with blades bent at a right angle with which to make the horizontal cut, but it is not indispensable (Fig. 571).

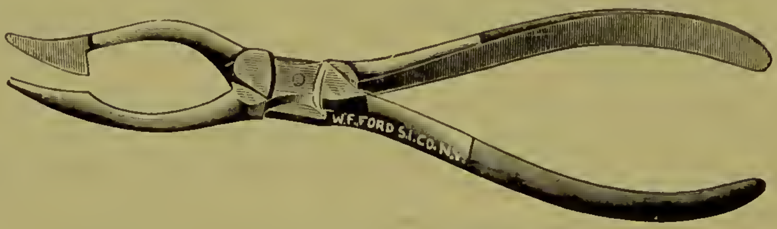

FIG. 570.—Straight scissors.

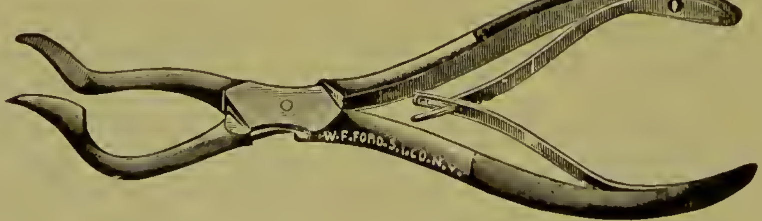

FIG. 571.—Angular scissors.

Second. A curved elevator for breaking up any adhesions that may exist between the septum and turbinal body.

Third. An Adams's forceps or one with stout parallel blades, as in Fig. 572.

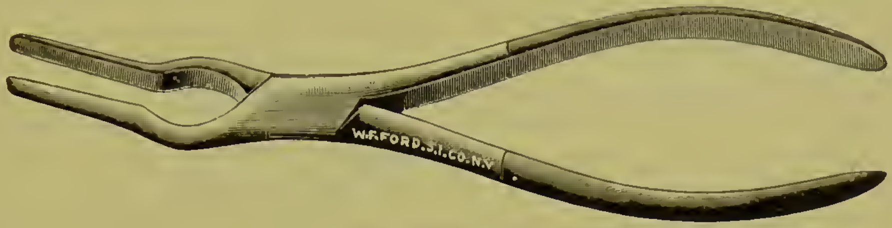

FIG. 572.—Compressing forceps.

Fourth. A hollow vulcanite splint of oval form and of a size according to the nature of the case. I formerly used a triangular tin splint, cut to adapt itself to the cartilage and held in place by a tampon of antiseptic gauze, but the discomfort experienced from the packed nostril and the danger of sepsis led me to devise the hollow splint (Fig. 573), which is thoroughly effective and by permitting the passage of air is more satisfactory to the patient. This splint is a tube of hard rubber of a proper shape to enter the nostril and hold the replaced septum in its new position. The splint as originally devised by me was rounded on its external surface—with perforations—which serve to retain it in place (Fig. 573). Dr. Emil Mayer of New York modified it by making it more oval in its caliber and consequently flatter on the sides (Fig. 574) and also larger. The splint slips up under the tip of the nose and is easily retained in its position. There have been other modifications proposed, but I am in the habit of using one or the other of these two, as the shape or size of the nostril may indicate. Both splints are made in various sizes.

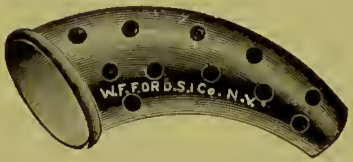

FIG. 573.—Asch's hollow splint.

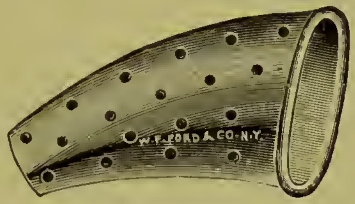

FIG. 574.—Mayer's hollow splint.

The mode of performing the operation is as follows:

Before etherizing, the nostrils are sprayed out with an antiseptic solution. I am accustomed to use Dobell's solution with the addition of a few drops of thymol and eucalyptol. The patient then having been etherized and the head drawn over the edge of the operating-table so as to permit the blood to flow into the naso-pharynx, the steel elevator is introduced into the obstructed nostril and any adhesions which may exist between the septum and the turbinal body are broken up. When a deviation is the result of traumatism or complicated by it, these adhesions are sometimes bony and require a good deal of force to divide them; in such cases I find a convex gouge to be of service. The blunt end of the scissors is then introduced into the obstructed nostril and the cutting blade into the other end. An incision is made in a horizontal direction across the greatest convexity of the deviation. The scissors are then removed and reintroduced and a vertical incision made at right angles to and across the center of the horizontal one, forming a crucial incision as near as possible over the most prominent portion of the deviation. The finger is then introduced into the *obstructed* nostril, and with it the segments made by the incision are pushed into the opposite one until they are broken at their base and the resiliency of the septum destroyed.

On this point depends the success of the operation, for unless the fracture of these segments is assured, the resiliency of the cartilage will not be overcome and the operation will fail. The septum is then straightened with forceps, and the hemorrhage, which in many cases is quite brisk, is checked by a spray of ice-cold Dobell's solution. A hollow splint of a size and shape suited to the case is then introduced into the affected nostril, a smaller one into the other, and the operation is completed. The splint in the patent nostril is introduced merely to assist in preventing bleeding, and is removed in twenty-four hours, as the one in the contracted nostril suffices to hold the septum in position. This splint is removed on the second day after the operation, cleansed thoroughly and replaced, after which it is taken out, cleansed and replaced every day for at least five weeks, by which time the healing of the septum in its modified position should be complete. After the fourth day it will be easy for the patient himself to remove and replace the splint, reporting to the surgeon once or twice a week for observation until there is no further use for its application.

It sometimes happens that the lower segment of the cartilage projects into the nostril. Nearly always this projection is absorbed if left to time, but it can easily be removed by the electro-trephine or the galvano-cautery. Perforation following the operation is so rare as not to be considered as a probable sequence. The few cases which I have seen where it occurred were due to cachexia and to unskilful performance of the operation. It will not suffice, however, to make the incision, insert the splint, and let the wound take care of itself in order to get a successful result. The patient must be seen every day for the first week, and at least twice a week after that until cured.

The operation is equally effective, whatever may be the character of the deviation; whether simple convexity, sigmoid, or vertical, the same procedure will apply to all, merely taking care that the incision be made with reference to the shape of the deformity.

Other operations for the deformity consist of the removal of the prominent portion of the convexity by saws, chisels, or burrs operated by the electromotor; but these methods are only available where there is much thickening of the septum and when the permeability of the nostril can be attained without the risk of perforation. It sometimes happens that the thickening of the septum is so great as to permit of this being done, but this condition is rare.

Thoroughly unsurgical is the method of Blandin, in which, by means of a punch, a circular piece is removed from the most prominent part of the deviation—a procedure which does not cure the deformity, but simply allows the air to pass out from the unobstructed nostril into the occluded one, while it substitutes one deformity for another, and there ensues a permanent ulceration with its attendant hemorrhage and crusts.

Cauteries and electrolysis have been used to remedy deviations of the septum, but as in the case of the saw these methods can only avail where the thickened septum is the cause of the obstruction.

Stoker and Hubert advise the use of laminaria bougies and of tampons, but it may be said with certainty that all such measures barely palliate. They cause irritation and produce conditions as unfavorable as the disease they are employed to cure.

A long experience has shown me that it is unwise to treat deviations of the septum otherwise than radically. In no other way can the discomfort produced by it be alleviated and the respiratory functions of the nose restored.

DISEASES OF THE TONSILS, PALATE, AND PHARYNX.

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DISEASES OF THE TONSILS.

General Considerations.—A proper understanding of the relations of the various tonsils to each other is obtained by regarding them all as segments of the so-called tonsillar ring—that is, the circular continuity of lymphoid tissue, starting in the naso-pharynx and extending on each side to the lips of the Eustachian tubes, thence to the posterior surface of the soft palate, to the space between the faucial pillars (forming in the latter region the faucial tonsils), and finally uniting in the so-called fourth or lingual tonsil at the base of the tongue.

The faucial tonsils are limited above by the approximation of the faucial pillars, but extend a variable distance below. They may be said to lie in the anterior part of the pharyngo-maxillary "interspace"—that is, a space between the lateral wall of the pharynx, the internal pterygoid plate, and the upper cervical vertebræ—lying almost directly back from the pharyngo-palatine arch. This "interspace" is filled with connective tissue. Behind it are both carotid arteries, the internal, 1½ cm., and the external 2 cm. distant from its lateral periphery. In healthy throats at rest the tonsils do not protrude beyond the level of the pillars.

Structure.—A tonsil, says Harrison Allen, is an association of diverticula developed from the epithelial layer of the mucosa, in the walls of which are grouped muciparous glands and lymph-follicles. The various tonsillar deposits vary only in the arrangement of these diverticula. In the lingual tonsil they are single; but in the pharyngeal and faucial, compound. In the latter the arrangement is such as to render especially noticeable the depressions—crypts or lacunæ (not follicles)—upon the surface. Soft in infancy, they become harder as age advances, partly from the growth of connective tissue and partly from a cortical hardening due to the constant impact of food. They begin to atrophy at middle life. Their more detailed anatomy and their physiology are elsewhere discussed. It may only be said here that a rarefaction of the epithelium is constantly going on at the surface even in health, and still more in disease; so that at times and in places this epithelial layer is only one or two cells thick. Hodenpyl has shown that the intact epithelium practically prevents any absorption whatever, but that its removal affords free access of infectious material to the lymph-channels: yet this claim must be modified in view of Goodale's recent experiments.[1] Various micro-organisms may effect a breach through this thinned epithelial layer. Hence the frequency with which the tonsils serve as the channel of entrance of various disease-poisons to the system.

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[1] *Trans. Amer. Laryng. Soc.*, 1898.

Finally, it is to be borne in mind that the pathological processes affect all the tonsils alike, and that variations in local symptoms are mainly due to locality.

ACUTE TONSILLAR INFLAMMATIONS.

This group includes the acute catarrhal, lacunar (wrongly called follicular), croupous, parenchymatous, and suppurative varieties. The catarrhal form rarely occurs apart from an acute catarrhal pharyngitis, under which heading it will be considered. The suppurative form, or quinsy, is really a peri- rather than an intratonsillar affection.

Acute lacunar tonsillitis is often associated with the parenchymatous variety, into which it frequently runs. It consists of an inflammation chiefly manifested by a filling of the crypts with whitish plugs of inflammatory exudation, together with a general congestion of surrounding parts, associated with a constitutional febrile reaction.

Causes.—Perhaps the most frequently assigned cause is exposure to cold. But at the outset it must be premised that in the light of our present views on pathology exposure to cold has very little significance as a causative factor in this class of diseases: it probably acts but indirectly and means only lessened resistance to morbific action. All sorts of micro-organisms are constantly present in the throat, the harmful influence of which is nullified by a sound condition of the organism. Exposure to cold, by temporarily lowering the resisting power of the tissues, allows the pathogenic germs to exert their effect.

A disordered gastro-intestinal canal is found in many instances, particularly in patients subject to the so-called bilious attacks. Causative factors are also found in the rheumatic and gouty diatheses. In regard to rheumatism, its frequency as a cause has, in the opinion of the writer, been greatly exaggerated. His records of 586 cases of various forms of tonsillitis and pharyngitis show 154 presenting evidences of rheumatic tendency, or 26.2 per cent.; while 432, or 73.8 per cent., presented no such evidences. These figures differ from those of Haig Brown, out of whose 119 cases 64, or 54 per cent., had some rheumatic tendency. Fowler believes that 80 per cent. of all cases of rheumatism have had previous sore throats; but the line of argument followed by him does not seem convincing with reference to the point at issue. Hope denies that the tonsils are a selective area for the rheumatic poison which, he says, attacks sero-fibrous rather than muco-fibrous structures, such as the tonsils really are. He even regards it as rare to meet with examples of recurring angina in those who carry recent or unmistakable evidences of a rheumatic attack.

Chronic enlargements of the tonsils naturally invite recurring inflammations. Suppressed menstruation seems to be a factor in some cases. Entrance of foreign bodies, sudden changes in atmospheric conditions, and exposure to odors from defective drainage are also causative factors. The latter may be regarded as a type of a wide range of septic influences. Hospital attendants frequently suffer from this affection.

Fränkel and Lennox Browne find intranasal operations to be a frequent excitant of this form of tonsillitis. It seems to follow the use of the galvano-cautery rather than that of cutting instruments. The reason assigned is that for a time after the cauterization the filtering function of the nares is held in abeyance, and that some of the bacteria found in the nose are stimulated into an abnormal virulence.

Pathology.—Either one or both organs may be affected. They are swollen and reddened, while the surrounding tissues become more or less edematous. This edema is frequently marked in the soft palate and uvula, the latter often being deviated to one side. The mouths of the lacunæ are filled with whitish plugs composed of dead epithelium, leukocytes, and various micro-organisms. Sometimes more or less thick tenacious mucus is so evenly spread over the walls of the lacunæ as to suggest a false membrane, but it can be easily brushed off, leaving no bleeding surface, and it does not contain fibrin.

As to bacteriological findings, both staphylococci and streptococci are present. Fränkel believes the latter to be the pathogenetic cause. Meyer found in 53 cases, 14 with staphylococci (generally staphylococcus aureus), 24 with a mixture of the two, and 15 with streptococci, in pure culture. A diplococcus resembling (and perhaps identical with) that of pneumonia has also been met with. The varying proportion of these two micro-organisms causes no appreciable variation in the clinical features of the disease. Meyer's researches show that the secretion from non-inflamed tonsils ordinarily contains a coccus very analogous to the streptococcus pyogenes, a small growth often arranged in pairs, staphylococci, and leptothrix growths.

Acute Parenchymatous Tonsillitis.—Very frequently the foregoing condition is present without any marked enlargement of the tonsil; but often the organ becomes greatly increased in size from the exudation of inflammatory products into its substance, so that we have a combination of the lacunar and parenchymatous forms; or, again, the organ may be greatly swollen while the mouths of the crypts are clear.

Symptoms.—The symptoms in both forms are essentially the same. The local manifestations may either precede or follow the general. The latter assume the type of an acute infectious disease. There is more or less chilliness, followed by fever of rapid rise (104° F.), with corresponding changes in pulse and respiration, headache, constipation, thirst, anorexia, general malaise, and bodily pains, with an amount of prostration out of all proportion to the apparent severity of the local lesion. The worst cases show clammy sweats, restlessness, insomnia, and even delirium. The local manifestations begin with pricking or tingling sensations referable to the throat, soon changing to a continuous pain. It becomes increasingly difficult, especially in the parenchymatous variety, to open the mouth; the glands of the neck become swollen and painful, the pain radiating to the ears. Partial bluntness of hearing, taste, and smell is not uncommon. A sense of suffocation (occasionally a real danger thereof) results from the glandular swelling. The throat is constantly filled with a thick, tenacious mucus, attempts at swallowing which (or also talking) greatly increase the patient's distress. The tongue is coated and the breath offensive. Deglutition is often agonizingly painful, and fluids sometimes regurgitate through the nose. Persistence of the fever sometimes brings out a rash of an erythematous type.

Differential Diagnosis.—Scarlatinal throats sometimes present lacunar inflammation, but here the disease is usually ushered in with vomiting; and the appearance of the rash within twenty-four hours settles the question. Also, the faucial congestion is generally much more extensive, while the actual swelling of the parts is much less. The appearance of the tongue also helps us.

In primary specific sore throat the lesion generally appears in symmetrical areas on both sides. The congestion is of a duller red hue; pain is slight and fever generally absent. In fact, it is rather from the simple catarrhal than the lacunar form of tonsillitis that this condition has to be separated.

From diphtheria the diagnosis is not always easy. We now recognize bacteriologically a lacunar diphtheria—that is, a true diphtheria with the exudate confined to the walls of the lacunæ. To the eye and in its clinical features it resembles precisely the lacunar form of acute tonsillitis. The culture-medium alone will enable us to decide. Many instances of reported contagion in lacunar tonsillitis have doubtless been truly diphtheritic. It may be said that in diphtheria the exudate occurs in large patches, is generally of a grayish hue, and of a more ragged appearance. A bleeding surface after removal is no proof of true diphtheria, but only of a croupous inflammation—that is, exudation with degeneration of tissue. Moreover, here the constitutional symptoms come on more slowly and the temperature rarely rises so high; indeed, may be even subnormal.

Course.—The disease lasts from one to fourteen days, averaging four or five. It may leave the tonsils chronically enlarged, or before subsiding go on to a quinsy. A few cases have resulted fatally, but the prognosis is regularly good.

Treatment.—If cases are seen at the very outset, the disease can sometimes be aborted by painting the tonsils with strong solutions of cocain, with pure guaiacol, or with silver nitrate (15 per cent. solution). A mercurial purge followed by a saline should be administered, and small and frequent doses of aconite, belladonna, or opium should be given. The writer has used with success the familiar "tonsillitis tablet" composed of—

℞. Tr. aconit.,	♏ $\frac{1}{5}$;
Tr. bryoniæ,	♏ $\frac{1}{10}$;
Tr. belladonnæ,	♏ $\frac{1}{10}$;
Red iodid of mercury,	gr. $\frac{1}{100}$.—M.

Of these, one may be taken hourly for three hours, and one every two hours thereafter. At the outset, cold compresses may be applied to the neck; while if the case goes on to full development, hot applications will afford greater relief. Frequent gargling with a hot solution of bicarbonate of soda in water will remove the clogging mucus.

Most cases, however, are well advanced when they come under medical care, and of remedies proposed in this and later stages there is no end. Guaiac given in the form of lozenges or dram doses of the ammoniated tincture has long enjoyed a reputation in curing this condition; but it is uncertain in effect and very disagreeable in taste. For some years the writer has had the best results with salol, given in hourly doses of five grains in mucilaginous suspension (not tablets) flavored with some essential oil. He has found that in a series of 81 consecutive cases, watched with reference to this fact, the pain was relieved on an average in fifteen hours. Allowing for sleep, not more than ninety grains are taken in the twenty-four hours, and this daily dosage is perfectly safe unless there be definite kidney-trouble. In a few cases of the above series the urine assumed a darkish color. Salicin has been credited (if continued for a week or more after the subsidence of the active symptoms) with the power of preventing subsequent persisting hypertrophy. Other drugs of value are sodium salicylate, antipyrin, and the muriated tincture of iron. The latter sometimes proves surprisingly efficacious after one has used in vain some of the newer and much-praised remedies. The self-limited nature of the affection must be borne in mind when estimating the value of any remedy. Scarifications, incisions, or punctures are not recommended in this form of tonsillitis. Occasionally relief follows the digging out of the crypts with a small sharp scoop.

It is well to isolate every case of sore throat, although the direct contagious nature of lacunar tonsillitis is still a matter of dispute.

Acute Croupous Tonsillitis.—By the term "croupous" is here meant an exudative inflammation leading to the degeneration or death of tissue. The change may involve the epithelial covering only, or may extend through the entire mucosa with swelling of the surrounding tissues. The exuded fluid, rich in fibrino-plastic material, coagulates on the surface of the mucosa, forming the false membrane.

Causes.—This variety frequently occurs as a complication of the exanthemata and various infectious diseases. It is seen occasionally in the later stages of renal trouble and of the wasting maladies. In one sense it may be said that the special form due to the Löffler bacillus is the lesion of diphtheria, but that is not what is meant by the title above used. It may also occur as a primary affection from almost any of the causes mentioned under the lacunar form.

Pathology.—We find here the typical false membrane from the coagulation of the exuded *liquor sanguinis*, rich in fibrino-plastic material, and from the emigration of leukocytes. Fibrin is thereby formed on the mucosa entangling the leukocytes, now appearing as pus-cells in its meshes. Subsequent coagulation-necrosis leaves either superficial erosions or ulcers of varying depth. Bacteriologically the staphylococcus and streptococcus are the most common excitant organisms. Some classifications would include the pseudo-bacillus of Löffler. It is not yet proven that a simple streptococcus sore throat is necessarily contagious in the popular acceptation of the word.

Symptoms.—These are in a general way the same as those of lacunar tonsillitis, although generally of a greater severity. The tonsil may be but little swollen and the exudate limited to its convexity. The swelling of the cervical glands is generally noticeable, as is also the prostration.

Diagnosis.—The disease most nearly resembling simple croupous tonsillitis is diphtheria. Here, again, it is asserted with much emphasis that culture-tests alone can decide in doubtful cases. The local appearance may, in the light of each practitioner's experience, incline him to this or that view, but bacteriology alone can settle the question. The disease generally runs from six to eight days, often leaving the patient very weak and anemic. Recovery is the regular rule.

Treatment.—The measures outlined for the treatment of the lacunar form may be tried; but in the majority of cases it is better to rely on a constitutional tonic-treatment and keep the mouth as thoroughly disinfected as possible. A 1 : 3000 bichlorid mouth-wash is as efficient as any, and when the membrane begins to come away, hydrogen dioxid solutions (equal parts freshly mixed with lime-water) may be employed.

Acute Circumtonsillar Inflammation.—It has been customary to speak of this disease as a suppurative tonsillitis or quinsy. The former is objectionable in that it implies that the tissue of the tonsil proper suppurates, while the truth is that this change takes place in the vast majority of cases in the connective tissue surrounding the tonsil, especially in front of and above it.

Causes.—These are the same as those of the varieties of inflammation previously described. Any case beginning as lacunar or parenchymatous may go on to suppuration. The latter may follow a specific affection of the organ, as in the case reported by J. H. Bryan.

Pathology.—We have here a pure phlegmon of the circumtonsillar cellular tissue. The tonsil may be pushed inward from the pressure of the inflammatory products and appear enlarged where it really is not. Occasionally the suppurative process actually invades the tonsillar substance. The abscess is more apt to point in the upper part of the anterior pillar or just above it; less frequently lower down in the posterior pillar. Occasionally the pus burrows its way to the bottom of one of the tonsillar crypts, through which it may be seen oozing to the surface.

Symptoms.—These are of much the same character as before given, and are generally of a severe type. If the suppuration is secondary to one of the other forms, the pus-formation may engraft upon the preceding symptoms a distinct additional rigor, with high fever and profuse sweating. The swelling in the fauces becomes extreme. The whole side of the pharynx becomes enlarged, tense, and brawny. The soft palate is pushed forward and a tumor may be felt in the neck. It is often impossible for the patient to open the mouth at all, even to admit a tongue-depressor. Swallowing is also often impossible. The uvula becomes edematous and obstructs free respiration. If left to itself and only one tonsil is attacked, the disease generally runs its course in a week, by which time the abscess will have burst. Recovery is prompt. The involvement of the other tonsil means another period of misery. A serious, though fortunately a rare, complication is edema of the glottis. The bursting of the abscess during sleep may cause some of the pus to be swallowed and the patient may awake choking. No fatal cases from this cause alone are personally known to the writer, but one or two are on record.

Treatment.—This is at the outset the same as for the lacunar and parenchymatous forms. If pus-formation is apparently brewing, hot sponges to the neck and the vapor from hops in boiling water are grateful to the patient. Alkaline washes help to keep the mouth clear from thick mucus. Early incision is advocated. It is permissible as soon as there is any fulness about or protrusion of the faucial pillar, and should be followed up by flushing the mouth out with hot water. Where we suspect pus the blade of the scalpel should be passed in at least half an inch, held horizontally, and the direction of the incision should be from without inward toward the median line. Deep-seated pus is in this way frequently evacuated where more superficial puncture would be useless. In other words, our aim is the general one to get rid of the pus as soon as it is formed, and we treat the abscess on general surgical principles. Internal remedies are useless after pus has once formed. The syringing of the pus-cavity with a long curved tube attached to a syringe full of antiseptic solution has in some cases apparently hastened convalescence.

The Lingual Tonsil.—The fourth, or lingual, tonsil is situated between the circumvallate papillæ and the anterior surface of the epiglottis. It resembles the faucial bodies in structure, except in that the arrangement of the diverticula of its epithelial layer is single, while in the faucial bodies it is compound. Concerning physiology and pathology, the same general remarks apply to both regions.

Simplicity of classification is furthered by saying that we may have here the simple catarrhal, the lacunar and parenchymatous, and the circumtonsillar varieties, as previously outlined. The list of causes and the nature of the lesions are identically the same. Ruault states that poisoned saliva from dental caries has a special effect on the lingual tonsil.

The general **symptoms** are those already described under the faucial tonsillar inflammations. The local symptoms vary somewhat from the faucial type, and this variation is due to the different area affected. Thus, the feeling as of a foreign body in the throat is especially prominent. Cough is frequently referred to the larynx, while the pain is especially referred to the root of the tongue.

In the lacunar type of the disease the constitutional symptoms are apt to be more severe than in the corresponding inflammation of the faucial bodies. The epiglottis may become swollen and even the structures around the glottic opening, thus causing dyspnea, which is at times alarming and sometimes demands operative relief. The initial pain is frequently referred to the hyoid region.

The circumtonsillar or suppurative form (lingual quinsy) is less common than in the fauces, owing to the scanty amount of connective tissue at the root of the tongue. The special point of importance is the recognition of the precise malady with which we have to do. The mirror and the finger should both be used as aids to diagnosis. Incision of a fluctuating area is preferably made with the galvano-cautery. It is worth remembering that these cases are sometimes *ushered in* by an attack of edema of the glottis. Spontaneous evacuation of the abscess during sleep, especially if it discharges posteriorly, introduces an element of great danger. Cases of chronic abscess and of retention-cysts in this region are on record.

The various forms are often overlooked because the physician contents himself with simply using the tongue-depressor, a procedure which does not bring the area of the lingual tonsil into view. The laryngeal mirror will reveal the lacunæ choked up with inflammatory plugs and show the enlargement of the tonsil as a whole, either as a median single mass or as bilateral masses separated by a furrow. Palpation with the finger will reveal the existence of fluctuation when pus has formed.

The **treatment** of these various forms of lingual tonsillitis is identical with that of the corresponding forms of the faucial affections. As local applications we may use tannin and morphin, glycerite of boro-glycerin, weak cocain solutions, and menthol in olive oil or albolene (gr. xv–℥j). During the acute stages the vapor of boiling water poured on hops is gratefully borne, and convalescence may be hastened by swabbing with diluted perchlorid of iron (one part to eight or ten of water). The worst cases of this variety may suggest Ludwig's angina.

Acute Ulcerative Tonsillitis.—Under this heading Moure has recently called attention to a sub-variety of lacunar tonsillitis characterized by the presence of large ulcers which closely resemble syphilitic lesions. The tonsils present, more frequently on their mesial aspects, grayish patches covered with a cheesy coating of some thickness, but easily removed and leaving a mammillated surface. The borders of the ulcer are clean cut but not particularly swollen. The remainder of the organ may or may not be enlarged.

These ulcers may be single or multiple, without any tendency to coalesce. They may follow one another on the same tonsil, so that the organ may at one time exhibit different stages of the lesion. The process seems to start as an acute inflammation in the crypts. The gross appearance is compared by Moure to that of a cauterized tonsil from which the slough is about to separate (Fig. 575).

No special cause for this sub-variety has as yet been proven. The disease seems to attack by preference young adults, and to be more prevalent in the spring and fall.

Symptoms.—These correspond to an extremely mild form of the ordinary lacunar disease. The cervical glands are rarely affected.

Treatment.—The ulcers should be thoroughly cleansed with zinc-chlorid solution (1 : 30) containing a little cocain, and then a bromid gargle in glycerin and water should follow. All pharyngeal irritants should be avoided. Initial curetting of the affected area has been done with success.

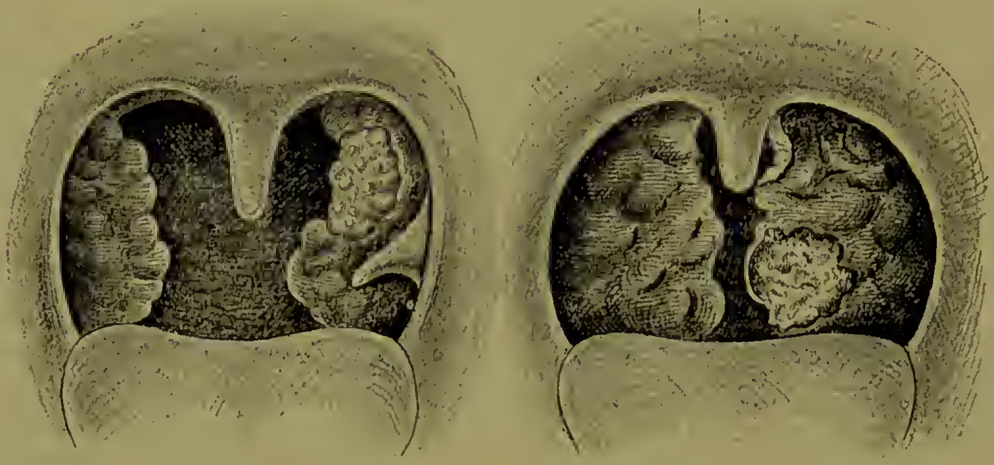

Fig. 575.—Acute ulcerative tonsillitis (Moure).

The writer has seen but one case which he would place under this heading. In this instance the left tonsil of an Italian, about thirty-five years old, presented a crateriform ulcer corresponding to the description above given. Doubtless certain cases of this nature have been regarded as ulcerating gummata. The gumma, however, is generally near the periphery of the tonsil, so that the neighboring parts are rapidly invaded. Moreover, the edges of the specific ulcer are generally surrounded by an angry red zone which is wanting in the lacunar ulceration.

CHRONIC TONSILLAR INFLAMMATIONS.

Modern pathological views enable us to distinguish the same varieties of chronic as of acute tonsillar inflammations. The chronic catarrhal form is really one element of a chronic pharyngitis, under which heading it is referred to. The existence of a chronic croupous form is a matter of some doubt. A special variety attended with an exudate due to the bacillus coli communis is referred to later in this article.

Chronic Lacunar Tonsillitis.—**Pathology.**—In this condition the tonsils are but little if at all enlarged, but the crypts become filled from time to time with cheesy masses. This seems to result from the narrowing or bridging over of the crypt-orifices, either by inflammatory processes or by a sort of villous ingrowth (Sokolowski) of the epithelium into the lacunæ. Retention of crypt-contents leads to dilatation, irritation, and inflammation. The plugs thus retained are composed of epithelial débris, leukocytes, fatty granules, cholesterin, and various mycotic elements. They frequently emit a very offensive odor.

Symptoms.—The symptoms of the condition are faucial irritability

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(tickling, burning, feeling as of foreign body), with pain radiating toward the ears, and increased on swallowing. The breath is fetid and the tongue frequently coated. Singing and smoking aggravate the symptoms. The expulsion of the plugs is followed by relief. The patients are frequently very much worried about themselves.

Inspection does not always reveal the condition. The probe must be used and the crypts explored. According to Gumpert, two sites must be closely scrutinized: (1) the upper extremity of the tonsil, between the pillars—the so-called epitonsillar fossa; and (2) the middle of the tonsil, directly behind the anterior pillar. The condition is frequently overlooked, and the faucial dysesthesia is referred to dilated lingual veins, enlarged pharyngeal follicles, hysteria, etc. Meanwhile, the patient gets no better.

Treatment.—The crypts should all be cleared out by some spud-like instrument or scoop and then slit up thoroughly. The bared areas should then be vigorously rubbed with a strong solution of iodin and potassic iodid, of each ʒjss to water ℥j. This generally effects a permanent cure.

Chronic Tonsillitis Due to the Bacillus Coli Communis.—Recent French writers have insisted that there exists a form of chronic tonsillitis due to the bacillus coli communis, and with a definite clinical course. Its characteristics are:

1. Its chronic course, beginning, it is true, with a brief stage of acute inflammation.
2. Its extreme persistence, since none of the therapeutic measures habitually directed against anginas are able to modify it. In one case only excision of the tonsil sufficed to remove it.
3. The slight intensity of the local subjective symptoms, no pain in the throat, no dryness or hypersecretion; at times a slight difficulty in swallowing when the exudate becomes confluent.
4. A notable deterioration out of all proportion to the local condition, and generally manifested in digestive disorders. These features are clearly of tonsillar origin, as they lessen after the clearing out of the crypts, but return upon the reappearance of the exudate.
5. The characteristic appearance of the tonsillar exudate—viz., a dull-white color, semisoft consistence, punctiform masses emerging from the crypts, but not, as a rule, encroaching upon the intercryptic surface, the mucosa covering which presents only a slight redness. Occasionally the masses coalesce, suggesting a pseudo-membrane, slightly adherent but removable without leaving a bleeding-surface, resistant, and not disintegrating when placed in water.
6. The integrity of the peritonsillar and pharyngeal regions.
7. The absence of glandular enlargements.

Bacteriologically, the exudate shows a pure culture of the bacterium coli commune, not only on the surface but in sections of the tonsillar tissue. The micro-organism differs from that isolated from the intestine in certain minor culture-reactions.

The authors, moreover, declare that this germ is frequently found in healthy human mouths, and express the belief that this form of tonsillitis is frequently overlooked. The most common condition with which it might be confounded is the ordinary leptothrix mycosis. But in the latter the exudate is generally hard and horny, is removed with difficulty, and under the microscope reveals its characteristic mycelial threads and spores.

Chronic Parenchymatous Tonsillitis.—This is one of the most common affections with which we have to do. It may occur as the result of preceding acute attacks; or it may be seen so early in life that it is impossible to say just when it began. It is regularly found in strumous children and in those living under bad hygienic surroundings. It may, however, occur in grown people without any dyscrasia and in those comfortably housed and fed.

Pathology.—The entire tonsil is enlarged (one or both) and of varying consistency. In the child or in very recent cases in the young adult it feels more or less pulpy, while in the older cases it is distinctly hard. Under the microscope it is seen that the lymphoid elements have undergone a true hyperplasia and that more or less connective tissue has developed. This may be seen even by the naked eye as irregular trabeculæ running through the mass, and by their contractile tendency hardening the latter (Fig. 576).

Not infrequently we find that the anterior pillar of the fauces appears as a broad and thick fibrous band, which completely envelops the anterior half of the tonsil; and by a process, apparently of contraction, has pressed and rotated the latter backward, so that whatever remains of its free surface presents toward the posterior wall of the pharynx. Adhesion to the posterior faucial pillar may also occur.

This connective-tissue development bears on the question of possible hemorrhage after tonsillotomy. It leads to a canalization of the bloodvessels, so that after section their mouths are held open and they cannot retract within their sheaths. The organ may feel soft at the surface but be quite hard at the plane of the section. Its general state constantly invites fresh inflammatory attacks. The crypts become clogged up, and the waste products accumulating behind these plugs lead to renewed inflammation. Removal of a layer of surface-tissue corresponding to the depth of these crypts will often give surprising relief to the constant series of outbreaks, although, of course, such a plan of treatment is to be condemned as not being sufficiently thorough.

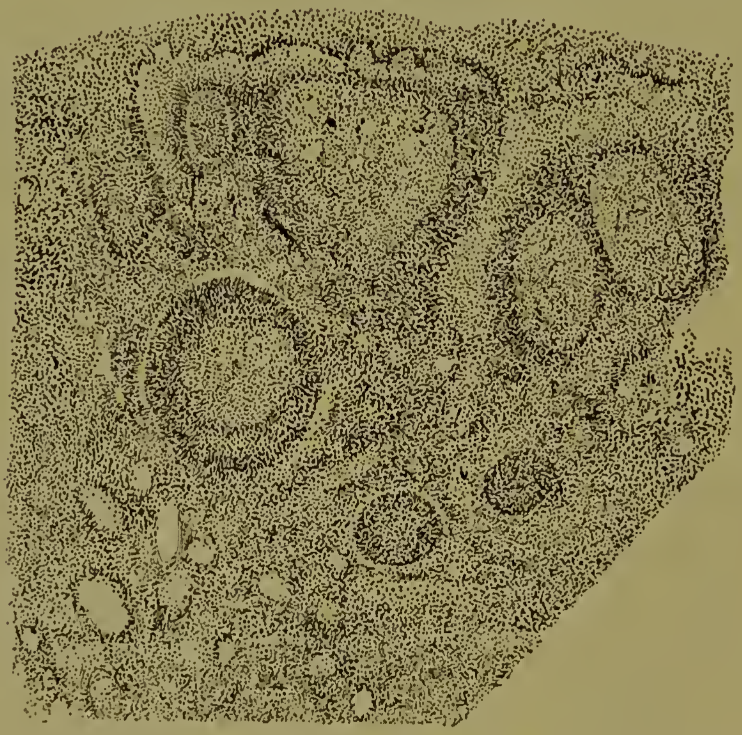

FIG. 576.—Hypertrophy of the faucial tonsil (Seifert and Kahn).

Symptoms.—Enlarged tonsils are in a sense foreign bodies and give rise to symptoms accordingly. All functions of the surrounding parts are more or less hindered. An enlarged pharyngeal tonsil (so-called "adenoid vegetations") may coexist with enlarged faucial tonsils; and it is difficult to determine to which of the two areas of diseased tissue a given symptom is to be referred. The voice is thick, the patient speaking as if the mouth was partially full, and some of the normal nasal resonance of phonation is lacking. Breathing is somewhat interfered with, although in adults true dyspnea is rare. In children, however, the oro-pharynx seems to be encroached upon, so that a slow carbonic-acid accumulation in the system takes place. Snoring and mouth-breathing may occur. The need of oxygen finally becomes so great that the child, if asleep, will wake up suddenly, presenting the familiar "night-terrors." The senses of taste, smell, and hearing are more or less blunted, and there may be actual aural inflammation. The enlarged tonsils, moreover, interfere mechanically with the actions of the delicate muscles which govern the functions of the Eustachian tubes.

Children with enlarged tonsils are apt to suffer from defects of chest-development and general physique. They will sometimes improve with marvellous rapidity after the pharynx is cleared out. Doubtless many chest-deformities referred to enlarged tonsils should be referred along with the latter to some underlying diathesis. The breath is offensive, the stomach frequently disturbed, and the bowels disordered. The inspired air passing over the diseased crypts containing cheesy plugs of decayed epithelia, fermenting mucus, and particles of food, the child is constantly inhaling a vitiated atmosphere. Nocturnal enuresis is sometimes present.

Diagnosis.—Even a casual inspection of the fauces will reveal the enlarged masses, which the act of gagging throws out still more prominently into view.

Treatment.—The condition offers no hope of improvement if left to itself. It is true that the tonsils will atrophy in later years, but by this time irreparable damage may have been done in various directions. If the tonsils are large enough to cause any of the foregoing symptoms, they should be removed. The only question is as to preference of methods in such removal.

In children tonsillotomy with some approved instrument is preferable (for operation, see page 1205), and it is the writer's experience that a more satisfactory removal can be accomplished without anesthesia than with it.

Where the tonsils are large but flat and non-projecting it is difficult, if not impossible, to engage any considerable portion of them within the ring of the guillotine. Under these circumstances we may employ ignipuncture (see below) or the method of Ruault—" traitément par morcellement." He has devised a tonsil punch-forceps, by which pieces of the tonsillar substance may be bitten off. This instrument will engage in the tonsillar tissue if the surface of the latter is at all uneven. If it is smooth, the crypts should first be scraped out, adhesions to the faucial pillars broken down with a palate-hook, and the tonsillar surface incised with a small blade set at a right angle to the axis of its shaft. In this way bits of tissue are presented to the punch-forceps for removal. After bleeding has ceased, the raw surface should be vigorously rubbed with a cotton-carrier dipped in a solution of iodin 1 part, potassium iodid 1 part, water 8 parts. A smart stinging sensation ensues, which passes off in twenty minutes. Secondary retraction of the stump greatly increases the amount of reduction in size.

In older patients the use of the guillotine is somewhat hazardous, owing to the liability to hemorrhage. We may use here either the cold-wire or galvano-cautery snare—the latter being the one more frequently employed. The cold snare can be used with a stiff wire which can be accurately adjusted. It can be tightened slowly and hemorrhage thereby avoided. It is extremely painful, and owing to the time its use requires, the latter necessitates in children a general anesthetic. In adults the cold snare can be used under cocain.

The hot snare (galvano-cautery loop) has the advantage of being practically a bloodless operation. The wire should be of irido-platinum, which is much stiffer than pure platinum wire, while retaining also all of the latter's advantages. It is somewhat difficult to adjust the loop and hold it in position until the current can be turned on, unless the tonsillar mass to be removed is of considerable size. It is therefore often of service to make on the posterior aspect of the tonsil a groove either with a bent electrode or with the concavity of the loop itself. In this way the latter will hold and not slip off when it is tightened. The current should be turned on and off alternately, the snare being tightened in the meantime, the latter part of the cautery-section being slowly made.

It is not necessary to remove the entire tonsil. A thick slough will eventually come away, causing a still further shrinkage of the tonsil. It has been said that entire removal of the latter leaves an annoying dryness of the mouth, but this has not been the personal experience of the writer.

Where the shape or disposition of the tonsillar structures is such as to necessitate removal by piecemeal or gradually, we have in addition to the method of Ruault that of ignipuncture. This can be made practically painless by injecting one or two drops of a 5 per cent. cocain solution under those areas selected for operation. The cautery-tip should be inserted deeply into a crypt, the current then turned on, and the tip be made to burn its way diagonally outward. Eight or ten such punctures can be made at each sitting. The throat is quite sore for a day or two, and it is better to attack only one tonsil at a time. Ice-water gargles and antiseptic mouth-washes can be used *ad interim.* There is a great variation in the rapidity of shrinkage after such treatment—some tonsils rapidly melting away, as it were, while others require repeated séances. Care should be taken to avoid burning the faucial pillars, for the minute cicatrices thus formed are apt to become neuralgic foci on every slight cold in the throat.

Of course, neither the cautery-snare nor -tip should be used without a rheostat. It must be remembered that contact with moist tissues quickly abstracts heat from the wire, and allowance must be made accordingly.

Chronic Inflammation of the Lingual Tonsil.—For all practical purposes only the parenchymatous variety need be mentioned. One case (perhaps others) has been recorded of chronic encysted abscess in this situation.

The affection has been commonly regarded as more frequent in women about middle life and with a history of previous menstrual disorders than in men. Out of 17,566 cases of throat-trouble, Lennox Browne found varicose veins at the base of the tongue associated with hypertrophy of the lingual tonsil in 1866, or 10.6 per cent. Again, in 1547 cases, 438, or 28.3 per cent. Of this latter group, however, only 31 per cent. were in women, while 69 per cent. were in men. Of his private cases, 99 per cent. were voice-users.

In any event the affection is one belonging to the period of middle life, and this is a point worthy of note, because at this age atrophy of all the tonsillar structures is generally present. Hickman has recorded the case of a child dying of asphyxia a few hours after birth, supposedly from a congenital glottic tumor, but the autopsy revealed an enormous hypertrophy of the normal tissue on the posterior part of the tongue.

Other causes are those in general of the various forms of chronic tonsillar inflammation, including especially all forms of irritant ingesta.

Pathology.—The enlarged lymphoid mass may be situated in the middle line, or there may be a mass on each side with a deep furrow between. The growths often project sufficiently to infringe upon the edges of the epiglottis and even to compress the latter (the so-called "incarceration of the epiglottis"). Minutely examined, we find nodular elevations which exhibit a well-marked umbilication. This latter is a central crypt due to a depression of the stratified epithelium. Such crypts are sometimes lined with ciliated epithelium. In minor cases the enlargement may consist almost entirely of an epithelial hyperplasia, which is hard and wart-like rather than soft like the typical lymphoid overgrowth (Fig. 577). The lymphatic channels from this region pass directly backward, and after coursing through the deep lingual glands join the deep cervical glands in the neighborhood of the bifurcation of the common carotid artery.

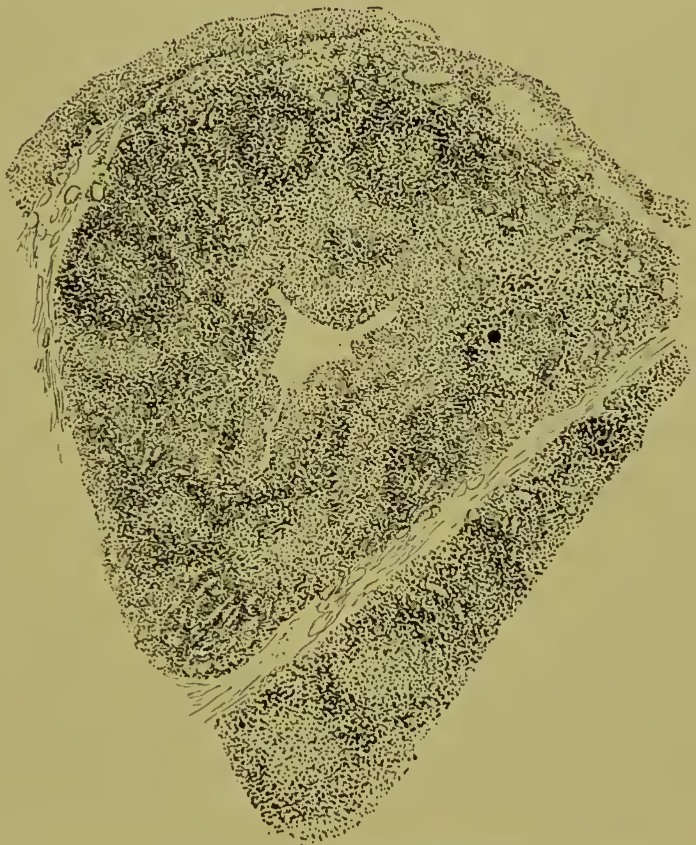

FIG. 577.—Hypertrophy of the lingual tonsil (Seifert and Kahn).

Symptoms.—The principal symptom is pharyngeal dysesthesia, manifested in a great variety of ways. There may be every intervening grade between a slight tickling and a sharp stinging pain. At other times there is a sensation as if the throat was grasped from the outside and forcibly compressed, or there may be the sensation as of a foreign body stuck in the tissues, with a constant desire to clear the throat.

Manifold varieties of reflex or direct neuroses are often present. The purity and vigor of the singing voice become impaired; esophageal spasm is frequently evoked, and the condition of the lingual tonsil should never be overlooked in searching for the cause of *globus hystericus*. Asthmatic attacks are not uncommon. The patients are, as a rule, extremely neurotic, and women especially are apt to fear that these pharyngeal disturbances are the forerunners of cancer.

Treatment.—The condition is not a serious one, and the annoyance it causes is out of all proportion to its real pathological importance. But patients have a just grievance and have a right to demand relief. This does not come without interference. Outside of the cessation of any vicious practice in eating, drinking, voice-use, etc., the end to be sought is the reduction in size of the offending mass.

If necessary, a previous application of cocain should be made before any manipulative measures are attempted. If the masses are large enough to engage in the ring of the tonsillotome (especially the Mackenzie instrument, curved to correspond with the curve of the tongue), the latter may be used to remove them. We may also use the cold-wire snare in a curved cannula, employing transfixion-needles to insure engagement of the snare in the tissue. The ordinary curved uvulotomy scissors will answer in some cases, or we have also at our disposal the hot snare.

When the growth is diffused, some sort of caustic must be employed. Nitrate of silver is useless because its action is too superficial. Chlorid-of-zinc solutions, caustic pyrozone, and chromic acid are at our disposal. Perhaps the cauterizing agent most frequently employed is the galvano-cautery tip at a dull-red heat, five or six punctures being made at each sitting. Caustics should not be recklessly used in this situation, for the formation of too much cicatricial tissue at this point may eventually aggravate the very condition we hope to relieve. More important than this, however, is the fact that too much irritation might start a neoplastic formation liable to assume a malignant character.

Hemorrhage after any cutting operation here is usually slight. Swelling is for a time very painful. Ice-pellets should be freely used. All hot drinks, spices, condiments, and coarse foods should be avoided for a day or two.

In the use of caustics special care must be taken to avoid injuring the epiglottis, which is apt to react severely to very slight trauma.

LINGUAL VARIX.

Apart from the enlargement of the lingual tonsil, the veins in this situation may become tortuous and dilated, assuming a varicose condition. To this have been given the names of lingual varix, hemorrhoids of the tongue, etc. As to the local physical condition, it is practically identical with that in rectal hemorrhoids.

Causes.—The affection is rare before the twentieth year, and far more common about middle life. It most frequently occurs in patients with torpid liver and those who suffer from chronic dyspepsia associated with constipation and piles. It may be present in almost any chronic visceral affection obstructing free venous return, and occasionally seems to be one of the local manifestations of a general tendency to vaso-motor neuroses.

Pathology.—The veins are entangled and appear as a network of dark-red or reddish-blue streaks or bands, with here and there local dilatations: or there may be actual nodosities, small ampullæ in which the blood-current stagnates.

Symptoms.—The symptoms are the same as those of simple enlargement, with the important addition that from time to time small hemorrhages may occur. These, while rare, generally give great alarm to the patient, as he is apt to regard them as the forerunner of lung-trouble.

Treatment.—The digestive apparatus and bowels should be regulated and any dietetic errors corrected. The vessels are best obliterated by the galvano-cautery tip at a dull-red heat and under the general precautions already noted.

CHRONIC ENCYSTED TONSILLAR ABSCESS.

Among the causes of tonsillar enlargement may be mentioned the occurrence of chronic encysted abscess. This condition has been carefully studied by Peyrissac, who has analyzed ten cases. Some presented a hard condition of the organ, suggesting a fibroma. They are to be regarded as similar in their mode of origin to the ordinary cold abscess, although they have no tubercular element. Bacteriologically, they have no characteristics other than those of abscesses in general, and do not seem to have any relation to a special diathesis.

An intermittent purulent discharge may suggest the nature and underlying cause of the tonsillar enlargement. The contents of the abscess-cavity may be grumous or syrupy in consistency. The pus-cells show marked fatty and granular degeneration, and are rich in cholesterin-crystals. The lining wall is apparently of a low grade of connective tissue, organized from the surrounding tonsillar parenchyma.

The **treatment** is not attended with any particular difficulty.

POLYPOID HYPERTROPHY OF THE TONSIL.

Apart from hypertrophy of the tonsil as a whole, we may have a localized enlargement giving rise in a lesser degree to the same symptoms as general hypertrophy and remediable by the same measures, especially the snare. In these adjunct masses there is generally an excessive development of connective tissue, resembling at times an actual sclerosis.

Such growths arise from one of three possible sources :

1. They may be accessory-tonsils.
2. There may be an elongation at the site of implantation of one or several lobules of a multilobular and hypertrophied tonsil.
3. The entire tonsil may become pedunculated.

CALCULI OF THE TONSIL.

Not infrequently small stone-like bodies, tonsilloliths, as they are called, are found in the tonsil or are discharged from its surface. They vary in size from a pin's-head to a pea, and a few very large ones have been reported. Their composition, as determined by Langier, is: calcium phosphate, 50; calcium carbonate, 12.5; mucus, 12.5; water, 25 per cent. The constant occurrence therein of cholesterin is a disputed point. It certainly has been found in some instances, as have also magnesium salts. The starting-point of formation may be a minute foreign body; but is generally a mass of retained secretion in the crypts. Various micro-organisms have been found embedded in these calculi.

The **symptoms** are those of a foreign body, sometimes causing tonsillar enlargement. Palpation and the exploring-needle will render the diagnosis certain.

Treatment consists in incising the tissue over the calculus, scooping the latter out and cauterizing its bed.

FOREIGN BODIES IN THE TONSIL.

These are generally either chicken- or fish-bones, pins, hairs, or bristles from a tooth-brush. Occasionally the entire foreign body becomes embedded in the tissue, but generally a portion projects and can be seen or felt. In case inspection reveals nothing we must always palpate. Removal by forceps is generally easy enough.

That large class of cases must not be forgotten in which the body has been swallowed but has left a slight lesion, causing much pharyngeal discomfort. This dysesthesia can be relieved by a mild cocain-spray. Even then it is difficult to persuade patients of the groundlessness of their fears.

XEROSTOMIA (DRY MOUTH).

This condition was first described in 1868 by J. Hutchinson who gave it the name it bears. Since that time some twenty-five cases have been recorded. The most prominent feature in all has been a persistent and extreme dryness of the buccal mucosa. The dryness may begin in the eyes and nose, extending thence to the pharynx and trachea. The teeth are apt to crumble. All the cases thus far reported have been in women.

The nature of the disease is unknown. It shows no constant lesion. In one or two instances the parotid glands have been enlarged, but the ducts have remained pervious. Many of the cases have presented coincident trophic changes in other parts of the body, suggesting the central origin of the affection.

All local or constitutional remedies have thus far proven useless. Pilocarpin and potassium iodid seem to exert no effect on the condition.

DISEASES OF THE EPIGLOTTIS.

It is unusual for the epiglottis to be the seat of primary inflammatory affections. It is generally secondarily involved, as in lupus, tuberculosis, and syphilis, in which it presents the lesions characteristic of these respective affections. It shares, so far as its mucous covering is concerned, in the various catarrhal conditions of the pharynx and larynx. In enlargement of the lingual tonsil the latter sometimes compresses the edges of the epiglottis, giving rise to the so-called "incarceration" of the latter. The epiglottis itself frequently responds to this irritation by growing larger, but this increase in size will disappear when the tonsil is properly removed.

The organ in health may be curved, angular, pendulous, or folded. Its edges may be smooth, serrated, or crenated. The under surface is always of a redder hue than the upper.

Concerning its function, we are still in considerable ignorance. It undoubtedly does help to protect the larynx from the entrance of food; but we know, both from animal experimentation and from the results of disease, that absence of the organ is not incompatible with easy deglutition. It has also been regarded as a "sounding-board," reflecting the vocal sound-wave to the pharynx, where it is in part articulated. If it is destroyed, the voice is less distinct, and if its edges are irregular and jagged, the voice may be rough and harsh.

The specific affections of the epiglottis are elsewhere considered. We have here to treat of simple enlargement.

Enlargement of the Epiglottis.—This is a pure hyperchondrosis, with more or less thickening of the mucosa covering it.

The **causes** are the same in general as those which lead to the production of chronic pharyngeal catarrhs.

Symptoms.—It is difficult to separate the symptoms of an enlarged epiglottis from those which may be referred to an enlarged lingual tonsil or a varicose condition of the lingual veins. We find here the same pharyngeal dysesthesia, pain in varying degree, irritative cough, empty swallowing, sensation as of a foreign body, vocal impairment, and gastric irritability. During acute exacerbations of catarrhal states painful swallowing is perhaps the most disturbing feature.

Rice has described a form of epiglottic inflammation caused by a natural size of the organ sufficient to bring it into contact with surrounding parts. The organ is abnormally hard throughout. In such cases the least exciting cause, as talking, singing, eating, going out into the cool air, change of body posture, etc., may cause an attack of coughing, or at least render the voice temporarily incompetent for any vocal effort.

Treatment.—This is in a general way that of the catarrhal condition always found in these cases, including, of course, the removal of all sources of irritation. Such measures, if faithfully carried out, will often reduce an enlarged epiglottis to its normal size. Astringent applications alone are of but little value. Cocain and oily sprays are but palliative, and their continued use is objectionable. The employment of the galvano-cautery generally provokes severe inflammatory reaction. Rice advises trimming off about one-eighth of an inch from the margins of the cartilage where they impinge upon the pharyngeal walls, using for this purpose long-handled curved scissors. Reaction is but moderate and hemorrhage is not excessive. He specially cautions against the removal of more than a narrow ribbon of tissue. Price Brown has used the galvano-cautery in one case where the epiglottis was long and narrow, but with its tip turned up into a horizontal position. No evil results followed.

DISEASES OF THE UVULA.

The anatomy of the uvula is elsewhere described. Concerning its physiology we are still uncertain, for the various functions assigned to it do not seem to suffer by its removal.

Malformations.—We can do no better than quote the statistics of C. Berens, who found in 3000 throats, 84 cases of abnormality in shape—viz.: hypertrophy, 11; pendulous, 2; fish-tailed shape, 39; attached to other parts, 2; deeply cleft, 14; worm-like shreds, 8; completely separate, 2; supernumerary, 4; also absent, 2.

Acute Uvulitis.—This is generally seen in connection with acute pharyngitis and tonsillitis, but may occur independently. It may arise from trauma (including excessive vocal effort), septic absorption, and occasionally after ignipuncture of the tonsils. The uvula becomes swollen and edematous. It may even bleed, and one or two cases have been reported in which there was a hemorrhage into the substance of the uvula itself.

Symptoms.—These are (1) general, in the form of a slight febrile reaction; and (2) local, as dysphagia, pain, a feeling that the throat is filled up, rarely dyspnea. There is generally slight dry cough, thick voice, and general pharyngeal discomfort.

Treatment.—The uvula should be punctured freely with a finely pointed bistoury, especially when the edema is marked. Demulcent washes, hot alkaline gargles, etc., may then be used, followed later by an astringent preparation, as:

℞. Tr. kino,
Tr. catechu co.,
Glycerit., acidi tannici, *āā* ℥j.—M.
S.—Teaspoonful in one-half glass cold water for gargle.

Chronic Uvulitis.—This is generally secondary to chronic catarrhal conditions of surrounding parts and cured by the treatment of the latter. It is an essential part also of elongated uvula, to be next considered.

Enlarged Uvula.—This condition is present in varying degree in nearly all patients who are subject to frequent sore throats of any kind, and especially in those who indulge in forced and unregulated vocal effort.

Pathology.—The enlargement may be a general thickening or merely an elongation. The latter may be merely a prolapse of the mucous membrane upon the muscular substance, or may be a true hypertrophy of the entire organ with downward extension, so that the tip rests on the dorsum of the tongue. There is always more or less paresis of the soft palate.

Symptoms.—The amount of disturbance produced by this condition varies greatly in different patients. Some with very long uvulæ make no complaint whatever. Generally there is more or less tickling, coughing, retching, and even vomiting. These may be excited by the sudden change from one temperature to another, by diffused cold to the skin (as in bathing), or when fatigued. In the worse cases there may be nocturnal glottic spasm, the uvula being most relaxed during sleep. The constant coughing sometimes causes rupture of the superficial vessels of the lower pharyngeal mucosa, and the patients bring up an occasional tinge of blood in the gelatinous pellets they expel. All these symptoms sometimes lead the sufferer to believe that he has serious lung-disease, but a removal of the offending tissue quickly reassures him. To vocalists an enlarged uvula is a serious menace. The voice becomes easily fatigued, loses its range, strength, and clearness, and frequently becomes tremulous.

In examining these cases the parts must be relaxed and nasal respiration maintained, else the soft palate will be drawn up and a wrong perspective of the parts be presented.

Treatment.—In those cases where the mucosa is merely edematous and prolapsed on the muscle, simple astringent troches and mouth-washes may suffice. If, however, their use for a reasonable length of time does not effect the requisite shortening of the organ, or if there is a true hypertrophy with elongation of the muscle, a portion of the latter should be removed. (For Uvulotomy, see page 1208.)

The normal organ averages in the adult about three-eighths of an inch in length, and when the mouth is closed should hang free in the fauces without touching the tongue. It must not be forgotten that the frequent hawking caused by enlarged uvula tends mechanically to aggravate still further the condition.

DISEASES OF THE PHARYNX.

The pharynx is a fibro-muscular funnel-shaped tube, extending from the under surface of the basilar process of the occipital to a point about opposite to the sixth cervical vertebra and on a level with the cricoid cartilage below. The upper part of the tube is expanded into a dome, imperfect in front, and likened to a "carriage-hood with the front window half-way down." At its sides are the common and internal carotid arteries.

Above, it communicates anteriorly with the posterior nares, laterally with the Eustachian tubes, in the middle with the mouth, and below with the larynx and esophagus. It has a strong fibrous investment, with a series of muscular constrictors and a mucous lining continuous with that of the surrounding cavities.

The epithelial lining is of the columnar ciliated variety in the dome and as low down as the floor of the nose; below it assumes the squamous type. It has a rich glandular supply, the acinous variety being generally distributed, less abundantly, however, in the vault; while the lymphoid deposits (not true glands) are massed about the orifices of the Eustachian tubes and in the dome, forming in the latter the third, pharyngeal, or Luschka's, tonsil.

In any consideration of pharyngeal maladies, two facts should be borne in mind. One is inherent in its structure and the other in its function. Being a combination of mucous membrane, muscle, and fibrous aponeurosis, it is naturally subject to the general run of acute inflammatory conditions; but it also bears the brunt of many outbreaks due to the gouty and rheumatic diatheses.

Moreover, the pharynx is a food- as well as an air-conduit. It has thus a relation to the digestive as well as to the respiratory tract; and disturbances of either may be caused by pharyngeal disturbances, or may even cause them. The existence of a scrofulous taint acts in the same direction.

Acute Catarrhal Pharyngitis.—This is an acute exudative inflammation of the mucous lining of the pharynx. This cavity is a veritable breeding-place for all sorts of micro-organisms, and yet in a condition of health they are harmless. Exposure to cold really means lessened resistance of the tissues to germ-vitality and germ-entrance into the substance of the membrane. The excessive use of alcohol and tobacco, the ingestion of irritant food, the presence of foreign bodies, etc., are accountable for many attacks. Gouty and rheumatic poisons frequently expend themselves upon this area. Another frequent exciting cause is a disordered state of the stomach and a torpid liver, especially that group of symptoms collectively known as a "bilious attack."

As predisposing causes we may have a bad general environment, poor ventilation, improper clothing, the breathing of noxious gases, and occupations of a sedentary character. The disease is more prevalent during the damp seasons of spring and fall, affecting especially those exposed to sudden temperature-changes. All ages suffer from it.

Pathology.—The affection is the simple type of acute exudative inflammation occurring in a mucous membrane, with its stages of congestion, swelling, dryness, and later increased secretion. It may be confined to various areas, as the post-pharyngeal wall, the palatal folds, the fauces, or may affect the entire cavity. Pretty generally the covering of the tonsils is involved, and we really have an acute catarrhal tonsillitis as well as pharyngitis. The mucosa may be shining and smooth or of a granular appearance.

Symptoms.—In a simple case there is generally a very mild constitutional febrile reaction. Locally, we have pain of various degrees of intensity, painful swallowing, irritative cough, with a constant desire to clear the throat. Viscid mucus is expectorated, sometimes in pellets and occasionally blood-streaked. Smell, taste, and even hearing may be impaired—the latter especially when the attack is engrafted upon an old tonsillar enlargement. The attack may pass off into "a cold in the head."

The **prognosis** is always good, the inflammation rarely extending to the deeper structures.

Treatment.—At the outset a mercurial and saline should be given, followed by aconite and belladonna in small but frequent and alternating doses. Pellets of ice are grateful, and in the milder cases relief may come from the free use of some astringent lozenge, such as the krameria or red-gum troches. Weak cocain solutions may be sparingly sprayed on to relieve pain, but a graduated atomizer should always be employed, so as to register the amount of the drug used. Menthol in albolene (gr. xv–℥j) is often just as efficacious. For this and similar purposes the "pyrozone-atomizer" may be employed.

In the diathetic cases, guaiac, salicylates, colchicum, and syrup of iodid of iron find their proper application. Iced compresses may be used externally. An edematous uvula or palate should be freely punctured. Food should be soft and non-irritating.

A simple tonic is often advisable after the subsidence of the acute symptoms. For the excessive secretion some form of astringent gargle is generally employed. A good formula is that given on page 938.

It has become fashionable in certain circles to decry the use of gargles on the ground that the fluid comes in contact with only a very small part of the affected area, never passing, as ordinarily used, beyond the anterior faucial pillars. The ideal method of gargling is that known as the "Von Tröltsch" plan. The patient sits, or better lies down, with the head thrown back. He takes a mouthful of the gargle and begins the movement of swallowing without letting the liquid go down his throat. He next throws the head suddenly forward, when part of the fluid will go up into the naso-pharynx and find its exit through the nostrils, while the rest escapes through the mouth.

It is obvious that but few patients can thus juggle with their swallowing-apparatus. Moreover, the method is painful at any time, and therefore practically inadmissible in many acute inflammatory states. As a matter of fact, however, Swain has demonstrated that by this method fluid may be brought in contact with the outer or extralaryngeal surface of the epiglottis, the ary-epiglottic ligament, the arytenoid cartilages, and the posterior commissure of the larynx, as well as with the upper surfaces. In the later stages of acute catarrhal pharyngitis mild antiseptic troches or mouth-washes may be of service. To avoid a repetition of the attacks proper foot-wear and woollen underclothing should be worn. The neck and upper chest should be douched night and morning with cold water and briskly rubbed with a coarse towel.

Chronic Catarrhal Pharyngitis.—Under this heading are to be considered the chronic catarrhal condition of the membrane as a whole, and also that distinct affection of its lymphoid elements known as "follicular pharyngitis." A localized variety of the latter is known as pharyngitis lateralis.

Simple Chronic Catarrhal Pharyngitis.—In this form the lesion is generally confined to the pharyngeal mucosa proper. The uvula, palate, and faucial pillars usually escape. The tonsils, however, are frequently enlarged.

Quite a difference of opinion exists as to the cause of this affection. The majority of writers would seem to regard it either as a result of repeated acute catarrhal processes, as in the case of mucous membranes generally, or as a disease set up by some of the long-acting causes named below. Bosworth emphatically states his conviction that "chronic pharyngitis is in no instance the result of repeated attacks of acute inflammation; but, on the contrary, the chronic process sets in first, whereupon its clinical history is marked by repeated attacks of acute catarrhal sore throat." According to his view, the condition is generally secondary to a chronic gastritis, especially that form due to alcohol.

A frequent cause is the inhalation of all sorts of irritants, including tobacco-smoke. Here again we tread on disputed ground, some claiming that the nicotin and irritating salts of the smoke will set up a pharyngitis *ab initio*, and others that they merely aggravate a pre-existing condition. Some cases seem to arise from the extension of a naso-pharyngeal process or to be aggravated by the constant hawking and straining of the pharyngeal muscles.

Finally it must not be forgotten that the pharyngeal mucosa is bathed by all the air inspired through the nose. Hence, if this air is not (owing to intranasal abnormalities) properly strained, moistened, and warmed, it will act as an irritant. Particularly is this the case if nasal obstruction is sufficient to cause mouth-breathing.

Pathology.—We have here to deal with a proliferative inflammation occurring in a mucous membrane. The blood-vessels take no share in the process, which consists in the formation of a low grade of connective tissue in the deeper layers. The mucous glands, which are here scanty, are not much affected. The secretion is apparently increased and abnormally viscid. The lymphoid elements are not involved. In some of the older cases enlarged veins may course over the surface.

Symptoms.—As the affection is so frequently associated with gastric disorders, the symptoms of the latter are very much in evidence in the form of flatulency, gagging, nausea, and even vomiting. Combined with these is a continuous smarting feeling in the pharynx, with special discomfort in swallowing spiced foods or hot drinks. A coexisting naso-pharyngitis aggravates all symptoms. The whole mucous lining of the pharynx is excessively irritable. It is often impossible at the first sitting to make a satisfactory examination. Particularly is this the case in institution patients, with their usual excesses in malt-liquors and inferior tobacco. The mucosa is of a dark-red, beefy color, which rarely extends forward beyond the posterior faucial pillars. The breath is sour and offensive, while the tongue is more or less coated.

Treatment.—In many cases the pharynx itself is best left alone for awhile and attention directed toward the removal of vicious practices in eating and drinking. If irritability of the mucosa prevents proper examination, weak cocain applications may be made, or the patient may be put under the influence of the bromids, using also a strong solution of the latter for a gargle. Alcohol and tobacco must be cut off entirely, and tea and coffee during treatment. The bowels should be regulated with salines and cholagogues. An alkali with a bitter may be given after meals. Greasy foods, pastries, etc., fall under the ban. But little fluid should be taken at meals, so as to ensure the proper mastication of the food.

These procedures will alone cure many cases of chronic catarrhal pharyngitis. If, however, local discomfort persists after the stomach is regulated, we may make local applications to the pharyngeal mucosa. Silver nitrate (gr. xv–℥j) or the zinc salts (except the chlorid) in the same strength may be used. These remedies are exactly as good as the host of new ones recently placed on the market. Nothing is gained in the cure of these common maladies by running after strange therapeutic gods.

A valuable menstruum for many topical agents is the new oleo-stearate of zinc, a union of stearate of zinc with benzoinated albolene. It forms a viscid whitish mixture, not disagreeable to the taste. It can be used as a vehicle for the ordinary run of topical agents.

Chronic Follicular Pharyngitis.—In this affection the brunt of the pathological process falls upon the lymphoid structures which lie in the deeper layers of the mucosa. This change is of the greater clinical importance in that the process seems to involve in some way not entirely clear the sensory nerve-filaments of the area, giving rise to symptoms causing great discomfort.

Causes.—Over and above all there lies a diathesis to which has been given the name of "lymphatism." It is a tendency of all lymphoid structures at an early period of life to take on an overgrowth. With the earlier writers this tendency figures under the category of scrofula. At the present time we are disposed to admit the affinity, though not the identity, of the two.

The lymphatic overgrowth beginning in childhood affects more or less all the lymphoid deposits in the naso-pharynx and pharynx. The evidences of disease in the former of these two regions greatly predominate, so that not until later years do the troubles referable to the follicular ailment in the pharynx distinctly show themselves. Bad hygienic general environment predisposes to this form of catarrh; but there is no reason to believe that it has any relation to rheumatism or gout.

Pathology.—The follicular enlargement is a distinct process from the beginning, and probably is never a passing over from the simple catarrhal process described in the previous section. It may be accompanied by a simple surface-catarrh. It may be diffused over the surface of the pharynx, which assumes a granular appearance (granular pharyngitis), or may localize itself at the sides, just behind the posterior faucial pillars. To these ridges or bead-chain-like deposits Schmidt has given the name of "pharyngitis lateralis." These ridges occasionally become adherent to the pillars, so that their union appears as large cords on either side.

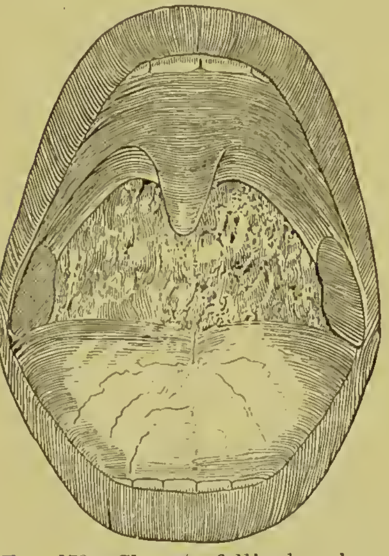

FIG. 578.—Chronic follicular pharyngitis (Cohen).

The affection of the follicles seems to be most pronounced near the mouths of the muciparous glands. The process is really one of hyperplasia, a true increase in the number of lymphoid elements, especially about the efferent channels of the lymph-nodes. This hyperplasia may be diffused throughout the deeper as well as the superficial lymphatic structure of the mucosa, causing a thickening thereof, or it may be localized as blunt masses projecting a little from the surface. At first these masses are soft, but in later years they grow smaller and harder and may even disappear, leaving no symptom; but their persistence in later years is the legacy of the changes during the time of "lymphatism" (Fig. 579).

Symptoms.—As the most prominent we note pharyngeal dysesthesia, due first to the unusually rich nerve-supply of the pharyngeal mucosa, and second to the fact already noted that the nerve-filaments are involved in the nodal changes. We may have all grades of sensation, from a mere discomfort to an actual pain. On account of this neurotic element it has been claimed that the disease is more common among women, but we have not so found it.

Overuse of the voice aggravates the discomfort. Painful swallowing is often felt. It has been suggested that the circulation through the follicles is increased and that attendant pressure-changes cause a true neuralgia.

The secretion is not, as a rule, increased in amount. Sometimes the follicles seem to lie on a bed of whitish connective tissue and the whole area looks very dry (pharyngitis sicca). The voice is husky, probably from a reflex influence upon the phonatory muscles. A dry nervous cough is often present.

The uvula may be elongated, especially when an accompanying nasopharyngitis produces much hawking. So, also, the faucial and lingual tonsils may be enlarged. Frequently the enlarged veins are seen coursing over the pharyngeal wall, but they are not distinctive of this condition. The disease may continue indefinitely, although without any extension to neighboring parts. There is no conclusive evidence that it predisposes to phthisis.

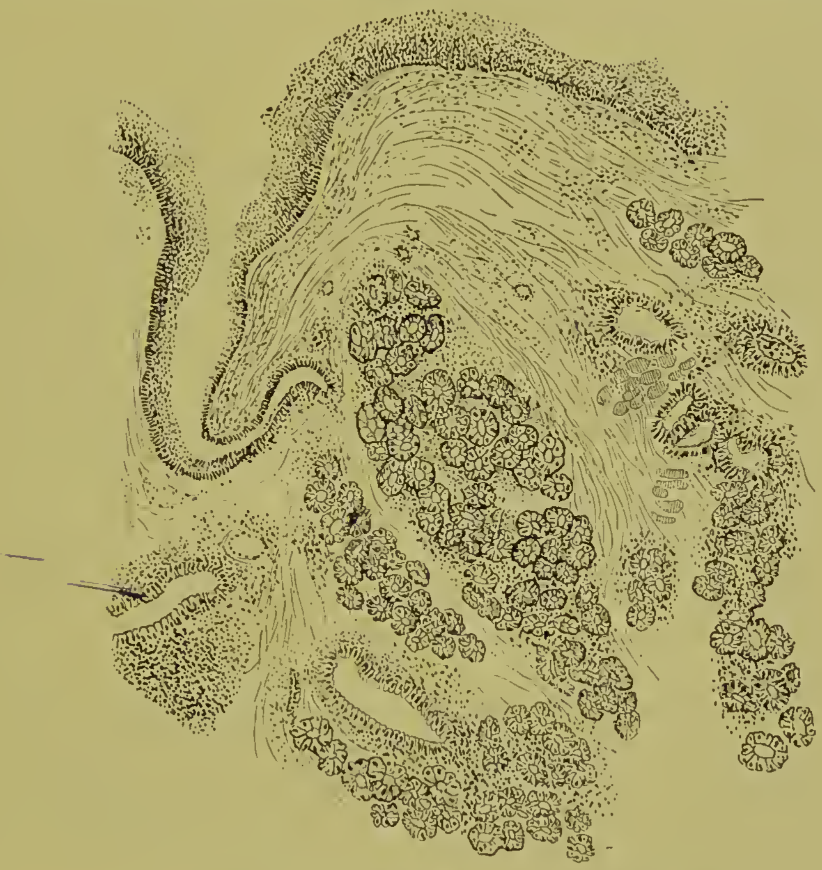

FIG. 579.—Pharyngitis granulosa (Seifert and Kahn).

Treatment.—As to general measures, we may refer to the treatment of the simple catarrhal form. The local treatment consists in the removal or destruction of the diseased follicles.

Of destructive agents we have chromic and trichloracetic acids, and the galvano-cautery at a bright cherry-red heat. Six or eight follicles may be treated at each sitting. A drop of 5 per cent. cocain solution injected at their bases through a curved needle will render the cauterization painless. E. Mayer curettes these diseased surfaces, and has devised a special instrument for this purpose and obtains excellent results. An antiseptic mouthwash should be used after cauterization.

In pharyngitis lateralis the same plans may be followed. Several sittings are required, and the reaction after the cautery is more severe in this situation than on the post-pharyngeal wall.

Hemorrhage from the Pharynx.—A brief note should be made concerning hemorrhages from the pharynx. These may be due to two different classes of causes: (1) Changes in the blood, and possibly in some cases in the blood-vessels, which permit the escape of the blood in various parts of the body—*e. g.*, purpura, hemophilia, leukemia, pernicious anemia, etc. (2) Ulcerations of various kinds, suppuration, trauma, the so-called "hemorrhagic laryngitis," and perhaps varicose veins. The latter source has been alluded to under "lingual varix."

Pharyngeal hemorrhages from the causes enumerated under the first of the foregoing divisions are rare. Under the second we may include cancerous ulcerations and also laryngitis sicca where the formation of crusts and their subsequent dislodgement may cause erosion of superficial vessels.

Tubercular ulceration of the larynx rarely, if ever, causes local bleeding, although the larynx may retain blood coming from the lungs or bronchi.

Where patients come to the physician with the history of having raised a little blood, the lungs are naturally first examined, and if there are neither signs nor symptoms of pulmonary trouble, the bleeding is referred to the throat and apt to be regarded as of slight moment. Such reasoning is fallacious. True pharyngeal hemorrhages are extremely rare, and their existence should never be predicated unless a clot or a bleeding-point can actually be seen upon the mucous membrane of the pharynx. In the greater majority of all these cases the blood comes from some part of the respiratory tract below the glottis—*i. e.*, signifies lung-trouble, whether there are any other signs or symptoms to correspond with it or not.

Of course, the mouth and gums must be carefully searched in this class of cases. So, also, allowance must be made for the existence of valvular cardiac trouble and pulmonary hyperemia. In some cases the blood escapes by diapedesis rather than by actual rupture of vessels.

It must be borne in mind that the intimate anatomical and physiological relations of the pharynx with the larynx and parts below permit blood effused in one situation to quickly deposit itself in another. Hence we must be cautious in our deductions as to the actual source of the bleeding. Moreover, blood effused high up in the tract may get into the lungs and so predispose to tubercular invasion.

Finally, we must be on our guard against malingerers who, for their own various purposes, can produce pharyngeal hemorrhage with the greatest readiness.

Pharyngo-mycosis.—Under this title are properly included all mycotic growths occurring in this situation. Among the parasites most frequently found here are the oidium albicans, actinomyces, aspergillus fumigatus, bacillus fasciculatus, and the growth causing that rare affection nigrities linguæ or black-tongue. By common clinical consent, however, the term, unless qualified, is restricted to cases of leptothrix growth. This form was first described by Fränkel in 1873.

Causes.—As predisposing causes we have preceding inflammations, especially of the tonsils, and carious teeth. It frequently follows acute tonsillitis, and has doubtless been often mistaken for a chronic lacunar affection. The exciting cause, or rather the essence of the disease, is the growth of the leptothrix-threads.

Pathology.—The deposits occur most frequently on the faucial and lingual tonsils, but they are occasionally seen on the pharyngeal tonsil, less frequently on the soft palate, post-pharyngeal wall, glosso-epiglottic folds, and larynx. J. Wright found them in one instance upon the inferior turbinal body. They appear as patches apparently embedded in the tonsillar crypts and projecting above the surface. They are generally hard and horny, being removed with great difficulty. They may exist as isolated areas of varying size or they may be connected by threads extending from one to another and interlacing like the tendrils of running vines.

If a bit of deposit is removed, teased in glycerin, and examined with a low-power objective, we note a mass of epithelia (an accidental feature) surrounded by irregular granules, in which are embedded the rod-like cells of various species of the leptothrix-fungus (belonging to the group of schizomycetes). These rods or mycelial threads generally occur in links, and sometimes curl up at their ends into fine hair-like filaments. Other rods appear colorless, but with sharp, dark borders, the centers seeming to be full of granular matter. The loose granules are in some instances the spores of the growth. Methyl-blue staining will bring out alternating colored and uncolored segments on the threads; while Lugol's solution gives with them the characteristic starch-reaction.

This fungus has never been cultivated outside of living bodies. Leptothrix-threads of various species inhabit every healthy mouth. The presence of tartar on the teeth, an altered reaction of buccal secretion, and a disordered digestion all seem to promote their growth. There is no proof that the gouty or rheumatic states predispose to them. They are found in rhinoliths, tonsillar concretions, and vesical calculi; in the secretion of tracheal ozena, fetid bronchitis, and pulmonary gangrene; on the coating of the tongue in low fevers, in the lachrymal duct, intestine, vagina, and feces. Most of the cases of mycosis reported have been in young women. In any situation the growth may precipitate lime-salts from fluids holding them in solution.

A somewhat novel view of the nature of this affection is that advanced by Siebenmann, who contends that Fränkel's benign tonsillar mycosis, with its formation of solid horny matter, should be taken from the category of mycoses and put in that of hyperkeratoses of the mucosa. As a product of a less complete keratosis should be regarded the less complete epithelial keratosis which is found in all tonsils, and which is an excellent medium for the development of the organisms of decomposition. The collection of incompletely keratosed epithelium is therefore a constant menace to the surrounding tissues, analogous to cholesteatoma of the middle ear. Siebenmann would drop the name "pharyngo-mycosis" and substitute therefor "lacunar hyperkeratosis."

Symptoms.—These consist of constant irritation in the fauces and a pricking or a pasty feeling, with mild cough and difficulty in swallowing. In one case submaxillary glandular enlargement was noted. Schech has found fever with general malaise, weakness, and anorexia preceding the local deposits. The tonsils themselves may be a little red and swollen. Semon has seen the soft palate and uvula congested, the latter being also very edematous.

Course.—The deposits come and go sometimes regardless of treatment. There is no danger in the affection. It is of more pathological interest than of clinical importance.

Treatment.—All functional disorders should be corrected; the teeth must be put in good condition. In one of the writer's cases the deposits permanently disappeared as soon as this was done. Sweets must be cut off from the diet. A change of climate will alone cure some cases.

As to topical measures, nearly every caustic and antiseptic in the pharmacopeia has been recommended—*e. g.*, solutions of zinc chlorid, balsam of Peru in alcohol, iodin and carbolic acid in glycerin, salicylic acid in alcohol, borax, bichlorid, chromic acid, silver nitrate, and pyrozone. Smoking is reported to have cured one case, and an instance in the writer's experience lends some color to this view. Nicotin solutions, however, should *not* be applied. Some of the larger deposits may be torn away with forceps. The favorite measure is the galvano-cautery tip carried to the base of each deposit. Tonsillotomy may be done if the organ is large enough to engage in the guillotine. Internally, salol and the alkalies have been used.

Herpes of the Fauces.—This is one of the rare diseases. Obviously, different clinicians have had different conditions in mind in their use of this term. Else how can we account for the fact that of two prominent writers, one has seen only 12 cases in a lifetime, while the other reports over 100 cases in six years?

The disease consists in the occurrence on the uvula, soft palate, tongue, and inside of the cheeks of small blisters, resembling somewhat the customary herpetic patches seen on the skin. The tonsils and epiglottis may also be invaded, while the posterior pharyngeal wall regularly escapes. The affection may be unilateral or bilateral. It occurs more frequently in children, in those constitutionally delicate, and in neurotic young women. It is especially prevalent during diphtheritic outbreaks, in damp climates, and during the colder months. Many of the patients are distinctly anemic.

Pathology.—In the initial stages small distended vesicles are seen with a surrounding zone of inflamed mucosa. These occur singly or in patches. They may disappear by absorption, leaving no trace; or may burst, leaving shallow circular ulcers. The vesicular stage is a brief one, for the epithelial covering of the patch is so delicate that it cannot hold the fluid which collects beneath it except for a very short time. Still, again, the patches may coalesce, forming a large bulla, which after discharging its contents becomes covered with a membranous deposit, suggesting diphtheria. Bosworth records three cases where the eruption assumed the form of herpes iris—*i. e.*, "small rings of minute papules enclosing a patch of healthy membrane." He regards the process as a localized inflammation of the papillæ of the subepithelial layer of the mucosa originating principally in the terminal filaments of the nerves.

Symptoms.—These consist of a moderate febrile reaction and a burning feeling in the fauces, increased by deglutition. Occasionally there is a severe itching about the parts. The pain may radiate to the ears, nose, and even to the larynx. A similar rash may appear coincidently on the lips, thus assisting in the diagnosis. The fauces show a circular arrangement of the eruption, at times papular, or vesicular, or even pustular, with the later history above described.

Cause.—The duration is about a week, and patients always recover; but the mucous membrane may be left predisposed to infection. Successive crops of eruption occasionally prolong the disease.

Treatment.—All neurotic and anemic states must be corrected, for these cases frequently relapse. At the outset sedative and demulcent mouthwashes are indicated. Morphin and carbolic acid in glycerin may be applied to the painful areas. Potassium chlorate is useless, and may even increase the local discomfort. Mild caustics may prevent the spreading of the patches.

DISEASES OF THE NASO-PHARYNX.

Under this heading are considered acute and chronic post-nasal catarrh and enlargement of the pharyngeal tonsil, including lymphoid hypertrophy in the vault of the pharynx, the so-called "adenoids." Other naso-pharyngeal affections are dealt with elsewhere in this work.

Acute Naso-pharyngitis: Acute Post-nasal Catarrh.—This affection is essentially an acute exudative inflammation of the mucosa lining the naso-pharyngeal space. It is frequently associated with an acute rhinitis, or rather both lesions occur in that condition known as a "cold in the head;" but it is possible for either to occur separately.

Causes.—Exposure to cold and damp plays the chief exciting rôle. Here also should be borne in mind what has already been said regarding such exposure as related to temporary impairment of tissue-vitality. As occurring in very young patients, we generally find acute naso-pharyngitis associated with more or less enlargement of the pharyngeal tonsil, which in turn may have resulted from repeated attacks of acute rhinitis. The abuse of alcohol and tobacco, exposure to dust-laden air, noxious vapors, and various septic influences are all contributing causes. The relation of any particular diathesis to the acute form of the disease cannot be regarded as proven. Disease of the nasal mucosa is regularly present, and is regarded by some as the most frequent excitant cause.

Pathology.—As already suggested, the process here is the typical one of acute exudative inflammation, with its successive stages of congestion, dryness, swelling, and hypersecretion. The follicles are reddened and enlarged and bathed first in mucus and later in muco-pus.

Symptoms.—Cases are ushered in with a very mild febrile reaction, general malaise, and anorexia. The fever rarely rises to 101° F., and yet the patient is miserable out of all proportion to this temperature. There is a dry, smarting feeling in the back part of the throat, with painful swallowing. Owing to the close anatomical relation between the mucosa and the bony vault, this stage of dryness from arrested secretion is apt to be prolonged. The gastro-enteric tract is often in a torpid, sluggish condition, and we have coated tongue, nausea, or even vomiting and constipation.

From this stage the condition passes into that of hypersecretion, which generally affords some relief to the local discomfort. The discharge is at first whitish and mucous in character; but later becomes yellowish and of a muco-purulent consistency. It trickles down from behind the soft palate and is expectorated, or in very young patients swallowed; some of it may be blown out through the anterior nares. Such a muco-purulent flow increases the tendency to gagging and nausea. This secretion is viscid, tenacious, and glairy. After a varying period of these symptoms—from two to ten days—there ensues a third stage characterized by progressive improvement in all symptoms.

During the course of the attack the dry sensation in the naso-pharynx may amount to an actual pain, and suggests by its radiation a facial neuralgia. There may be a stiffness of the cervical muscles, as in muscular rheumatism. The voice may be of a nasal character, and a short irritative cough is not uncommon. During the stage of hypersecretion the lining of the Eustachian tube may swell, causing occlusion and more or less deafness.

Although the affection is quite distressing to patients, it is essentially mild, and if the nares are free does not extend to parts below. If, however, they are obstructed and the air is not properly warmed, moistened, and filtered, the pharynx proper may suffer in consequence.

Treatment.—This should first be directed toward the gastro-intestinal tract, for a restoration of the latter to activity may abort an attack. A mercurial followed by a saline should be given immediately. An initial full dose of quinin and Dover's powder with a hot bath and other diaphoretic measures are often of greatest service. For the headache and general malaise the coal-tar products—phenacetin, ammonol, lactophenin, etc.—in five-grain doses every hour, are valuable. Bosworth advocates aconitia in $\frac{1}{500}$-grain doses every hour or two until the pharyngeal pain abates.

For local relief cocain may first be used to deplete the vessels and allay pain. The amount of the drug employed must be carefully restricted. After free secretion is established, the naso-pharynx should be irrigated three or four times daily by any of the methods in common use. The writer prefers a small rubber catheter with a large number of very fine perforations at the distal end, while its proximal end is attached to a rubber bulb. This is filled by suction in the usual manner and then passed along the floor of each nostril until the perforated end is in the naso-pharynx. Gentle pressure on the bulb will discharge a series of fine currents, which will bathe the entire cavity without injury to the Eustachian cushions, but effectually removing all secretion. The solutions to be used should be rather more than lukewarm. They may be made up of glyco-thymoline, boro-lyptol, listerine, etc., one teaspoonful to three ounces of water. A cheaper and yet efficient solution is one teaspoonful to the pint of water of a powder composed of equal parts of chlorid, biborate, and bicarbonate of sodium.

After the second stage is passed, applications may be made on the post-nasal cotton-carrier of silver nitrate (gr. xx–℥j), or Mandl's solution: iodin, gr. v; potassium iodid, gr. xv; acid carbolic, ♏ ij; glycerin, ℥j. If much tissue-hypertrophy remains in the vault, the galvano-cautery or cauterizing acids are indicated. The use of a palate-hook greatly facilitates the necessary manipulations.

Chronic Naso-pharyngitis: Chronic Post-nasal Catarrh.—By this term is signified a condition characterized by the excessive discharge from the naso-pharynx of a secretion altered in quality as well as quantity. It may cling to the site of production or diffuse itself more or less over the surrounding structures. Its discharge is generally effected by a characteristic nasal screatus or hawking.

This disease is common in all lands, and affects especially dwellers near large bodies of water and in damp climates. It is especially common in America, and is sometimes spoken of by English and Continental writers as "American catarrh." It appears in every grade of severity, from a mere annoyance, scarcely noticeable, to a condition which renders the patient himself thoroughly miserable and disgusting to others.

Causes.—Many cases in adults are doubtless referable to neglected disease of the pharyngeal tonsil occurring in earlier years. In childhood all inflammations are prone to invade lymphoid structures. Such a tendency is often aggravated by some intercurrent infantile disease, especially the exanthemata. The various diatheses act through this intermediate lymphatic involvement. The use of tobacco and alcohol are to be considered as exciting causes, the former perhaps only aggravating a pre-existing disease; while the latter primarily affects the stomach, between which and the pharynx there exists, as we have seen, an intimate relation.

In regard to the effect of cold alone, as an excitant of the acute form

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which later subsides into the chronic, Bosworth strenuously insists that the chronic form precedes, and that cold produces exacerbations into an acute or subacute stage. Modern rhinology, however, assigns the most important rôle among the causative factors to the condition of the nasal chambers. The recognition of their true function has been the great advance in this field of medicine. They should be examined in every case of post-nasal catarrh. If they are diseased, some naso-pharyngeal lesion can be safely predicated. The normal secretion from the glands of the latter region is thin, clear, and bland. If, however, owing to intranasal disease, it is constantly fanned by a current of air which is cool, dry, and dusty, its proper elaboration will be interfered with. Cell-desquamation in the naso-pharynx is unduly stimulated. A thick, stringy, dust-laden mucus appears, very tenacious and removed with difficulty. If the disease progresses, crust-formation finally results.

Pathology.—In addition to the excessive cell-desquamation and abnormal secretion there is more or less diffuse hyperplasia of the lymphoid elements of this region. A noteworthy impulse was given in 1885 to the discussion of this question by the publication of Tornwaldt's monograph on the "Significance of the Pharyngeal Bursa." He assigned as a frequent cause of chronic post-nasal catarrh a diseased condition of this bursa. It may be the seat of chronic catarrhal inflammation or may be cystic, with a closure of the outlet. To such a condition, also, Tornwaldt referred a host of reflex symptoms in various parts of the upper air-tract. His views gained some adherents, but are now regarded as too extreme. He considers the bursa as a normal anatomical structure, but Schwabach, after examining over thirty different specimens, denied the statement that the bursa was a special anatomical formation. It should rather be regarded as an integral portion of the pharyngeal tonsil, sharing in common with the latter all pathological changes (Figs. 580, 581).

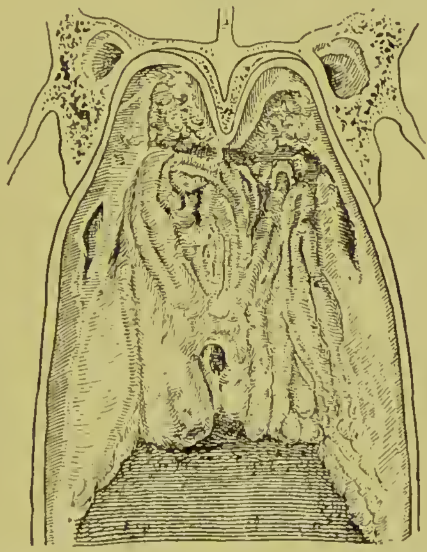
FIG. 580.—Pharyngeal vault, showing median and lateral folds; also, orifice of bursa (Luschka).

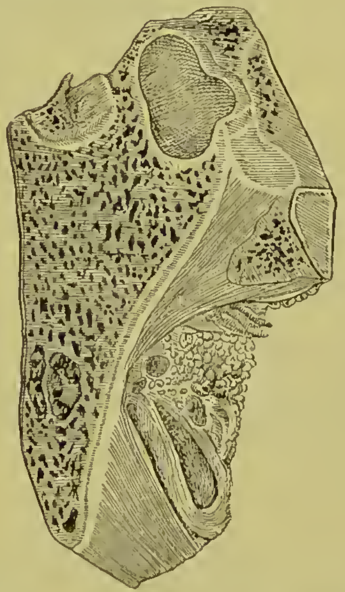
FIG. 581.—Pharyngeal bursa (Luschka).

The heads examined by Schwabach showed in the vault of the pharynx a series of irregular clefts of varying depth forming intervening ridges of variable breadth. The older the child the less distinct was this cleft-formation. The median cleft was the most persistent. The bursa, he asserts, is nothing but a remnant of this median cleft. Partial or complete agglutination of its edges forms a blind pocket or pouch, extremely favorable to the retention of mucus, which, under such circumstances, tends to become purulent, and a cyst results. Such inclusion-cysts are uncommon. Their epithelial lining is the same as that of the surrounding area. The columnar type here predominates, shading off into the squamous as we pass down the pharyngeal wall; but at times even in the vault the latter type prevails, owing to irritating secretions or the attrition of inflamed surfaces.

Examination of tissue removed from such cases shows first of all an epithelial layer with a range in structure from columnar ciliated to squamous cells. Underneath are lymph-nodes embedded in a mass of lymphoid tissue, which in turn presents trabeculæ of scanty connective tissue. The usual cryptic depressions appear on the surface (Figs. 582, 583).

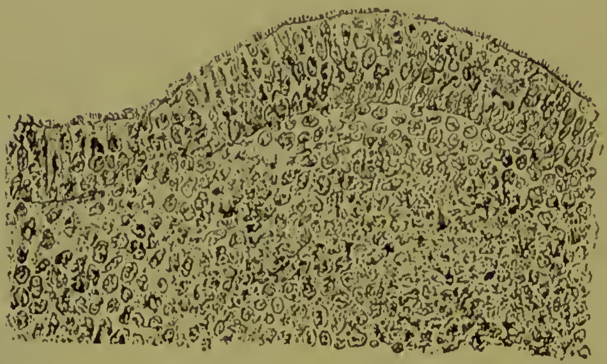

FIG. 582.—Lymph-follicle from naso-pharynx (altered from Zarniko).

Bosworth has pointed out the difficulty of recognizing the relation between the local pathological change and its most annoying symptom—viz., increased secretion. There is no increase of the ordinary muciparous follicles, and the increased secretion must therefore come from the surfaces of the clefts and ridges, which take on a functional activity not unlike that of a mucous gland. The mucus being itself abnormal, further irritation is caused, and thus the vicious circle is perpetuated.

Symptoms.—The most prominent symptom is the discharge of a profuse, viscid, yellowish secretion. It may adhere to the surface of the mucous membrane or flow down the posterior wall and be removed by frequent hawking. There is often the sensation of a pendant drop just behind the soft palate. We must suppose that this secretion is perfectly fluid as it appears at the mouths of the glandular ducts, and that its inspissation results from the abnormal environment it there meets. Its consistency varies from time to time. In those cases where there is an inclusion of the median cleft the discharge is more apt to be fluid. The cavity apparently fills slowly and then becomes a source of sufficient irritation to provoke hawking and lead to an evacuation of the bursal contents. During the day the natural activity of the pharyngeal muscles keeps the discharge from clogging up; but on waking in the morning the accumulation of the night-hours begins to be dislodged, causing gagging, nausea, and even vomiting. During the damp weather and at the sea-level the severity of the foregoing conditions is generally increased.

Does this form of catarrh predispose to affections of the lower air-tract—the larynx, trachea, and bronchi? This question has often been discussed. Probably none of the detached mucus ever goes down the windpipe. It glides along the post-pharyngeal wall into the esophagus. It is not, therefore, the carrier of contagion to the laryngeal mucosa. Patients who suffer synchronously from naso-pharyngeal and laryngeal catarrh are probably the victims of abnormal intranasal conditions. The correction of the latter is the only rational treatment of the twofold catarrhal malady.

Of reflex symptoms, we may cite asthma and headache. The middle-ear catarrh sometimes seen in naso-pharyngeal cases is probably due to intranasal trouble, causing improper ventilation of the pharyngeal vault and middle ear. It may at times be due to direct propagation of disease of the vault along the lining of the Eustachian tubes.

Diagnosis.—In the examination of a given case we must first ascertain whether we have to do with a post-nasal catarrh pure and simple or with one complicated by other morbid states.

In an uncomplicated case the small mirror will enable us to recognize either the broad diffuse hypertrophy of the mucosa or the enlarged "bursa." The latter appears as a cleft of varying depth with lateral rounded lips, making a picture which a French writer calls with greater realism than modesty the "vulva of the naso-pharynx." An accumulation of discharge here may result from syphilitic changes; but other evidences of the latter trouble will make the diagnosis easy.

It is difficult at times to eliminate as factors of the discharge the inflammation of the sphenoidal or post-ethmoidal sinuses. When the patient reclines the discharge from these cavities may trickle back into the naso-pharynx, and its appearance there simulates bursal disease. A careful examination made during the day, after previously cleansing the region, will generally determine whether or not serious trouble exists.

Course.—Patients have generally suffered, in a mild degree at least, for many years before coming under professional care. As a rule, the longer they have complained the more quickly they seem to think they can be cured. Most of them *can* be cured if they will follow up treatment long enough, but at the outset a full statement of the continued care necessary should be laid before them.

Treatment.—Any underlying diathesis which may be found will suggest its own appropriate remedy. Special attention must be paid to bathing, clothing, foot-wear, and general hygiene. Alcohol must be cut off in all its forms. At the outset tobacco must be given up, but later a mild cigar may be taken after dinner.

In regard to diet, no special rule can be laid down. More often the stomach-condition, if annoying, is the effect and not the cause of the naso-pharyngeal trouble. A cure of the latter will often remove the former.

As to local treatment, the number of remedies is legion. One is probably as good as another if thoroughly applied. Naso-pharyngeal cleanliness is the foundation-stone of all successful care of these cases. From two to four times daily the vault should be cleansed with some one of the solutions named in a preceding section (boro-lyptol, glyco-thymoline, pyrozone, listerine, etc.), all in the proportion of one to two teaspoonfuls in four ounces of water. Available also are the old-fashioned Dobell's solution or the alkaline powder (equal parts of salt, borax, and baking soda: of the mixture, one teaspoonful to the pint of lukewarm water).

These washes may be snuffed up from the hand or used in the nasal douche-cup or familiar "feeding-cup" of the sick-room. Ordinary atomizers spraying through the anterior nares are useless. The diseased surface must be laved with a certain volume of alkaline or antiseptic solution at body-temperature, so that all the adherent secretion may be floated up. Of course, too forcible manipulation of any kind should be avoided.

After the parts are thoroughly cleansed, some alterative application may be made on the cotton-carrier, such as the glycerite of tannic acid, or of boro-glycerin or a solution of iodin gr. v, potassium iodid gr. xv, carbolic acid ♏ ij and glycerin ℥j; silver nitrate gr. xxx–℥j; glacial acetic and lactic acids in varying strengths. All have their advocates. Such applications should be made three times weekly.

The nasal douche with the usual reservoir and long tube has not been advocated, as the writer is convinced that but few patients are sufficiently skilful in its management to render its use entirely safe. The douche-cup will suffice for every case if it is faithfully and persistently used. It can do no harm if of a proper shape and size. In office-practice, the long, hard-rubber syringe with curved tip will answer every purpose. An elaborate air-spray apparatus is in no wise necessary.

If the disease be more pronounced it will be necessary to actually destroy or remove the diseased tissue. For this purpose we have chromic acid and the galvano-cautery. With the latter the bursa can be thoroughly eradicated. Small curettes and some of the varieties of post-nasal forceps are also available. The use of the palate-retractor and post-nasal mirror are necessary for accurate manipulation of these instruments, use of which should be preceded by cocain on the cotton-carrier in 20 per cent. solution.

Lymphoid Hypertrophy in the Pharyngeal Vault.—This is the familiar condition variously known as hypertrophy of the third, pharyngeal or Luschka's tonsil, adenoid vegetations, etc. It was first described by Czermak in 1860, but he did not appreciate its clinical importance as we understand it to-day. It remained for the late Wilhelm Meyer of Copenhagen to accurately portray the affection. So thorough and complete was his exposition of the subject, that no one has been able to add anything essentially new to his now classical paper which appeared in 1870.

It is unfortunate that the term "adenoids" has come into such common use. It is in this connection anatomically incorrect. It was formerly supposed that the hypertrophy was made up of true glandular tissue, hence adenoid in structure; but this tissue contains no true secreting glands. Its folds and fissures may at times take on, so far as the elaboration of mucus is concerned, a secreting function.

Causes.—The condition may be congenital. Scrofula, syphilis, and tuberculosis all predispose to it. It seems hereditary in some families, but the existence of several cases in the same family may easily be referable to the same diathesis or to exposure to the same unsanitary surroundings. No race or climate is exempt from the disease. The majority of cases are seen in children from four to ten, although no age is exempt. Both sexes are equally affected. An underlying factor exists in the tendency of children to "lymphatism," which has been described in a previous section. The ebb of the lymphatic tide comes about the time of puberty, when there is a tendency of the lymphoid structures to atrophy.

Associated lesions of the malady are hypertrophic rhinitis and especially enlarged faucial tonsils. In a few cases the nasal mucosa may be distinctly atrophic.

Pathology.—The lymphoid masses are variously arranged in the naso-pharynx. Occasionally they are pendant from the vault; but more frequently they are irregularly distributed, running forward to the edges of or even into the choanæ, filling the fossæ of Rosenmüller, encroaching upon the

Eustachian orifices, and extending a variable distance downward upon the posterior and lateral pharyngeal walls (Fig. 582).

Under the microscope, the tissue is seen to be covered with stratified columnar epithelium, more or less deprived of its ciliæ. The surface is deeply furrowed, giving the mass a lobulated appearance. The bulk is made up of lymphoid cells with a scanty blood-supply. These cells are arranged in the usual "node" form, with internodal areas sparsely supplied with a low grade of connective tissue which, however, has a fairly abundant blood-supply (see Fig. 583).

These lymph-nodes resemble in every respect the solitary follicles of the intestine, and have the same relation to the lymphatic system. The lymph-vessels run near the bottom of the folds into which the surface is thrown. The blood-vessels are for the most part atypical in structure. Those which are at the bases of the masses—*i. e.* nearest to normal tissue—may, however, show a more typical structure. The amount of connective tissue present does not bear any necessary relation to the age of the patient. As a rule, the masses are softer in young children and harder in adults.

It must be remembered that this lymphatic formation is merely an overgrowth of a normal histological element of the mucosa in this situation. It is not an adventitious deposit. Therefore, those who speak of complete removal use a term which, strictly speaking, is not correct, for absolutely complete removal would mean a removal of the mucosa itself.

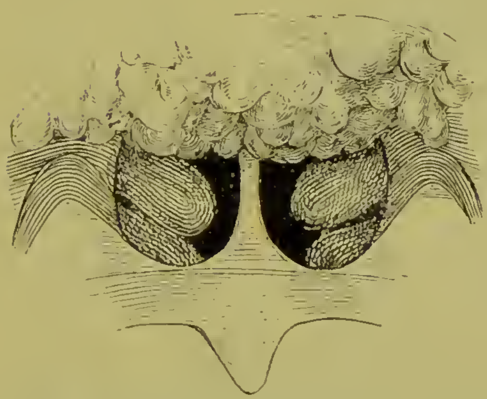

FIG. 583.—Lymphoid hypertrophy in the naso-pharyngeal vault.

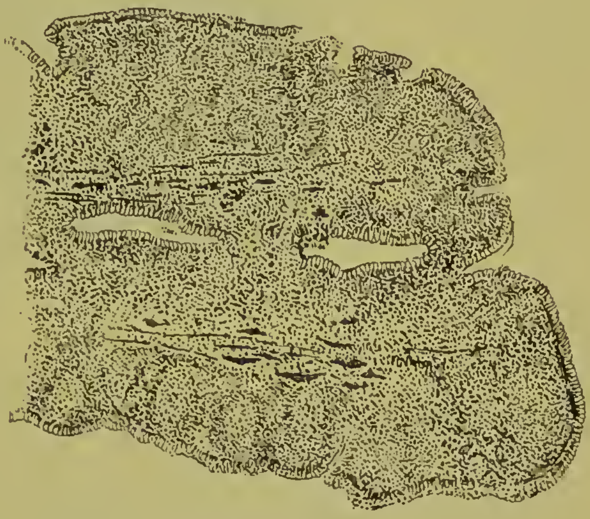

FIG. 584.—Section through lymphoid growth (altered from Zarniko).

The relative preponderance of the cellular elements gives to the growths their soft jelly-like consistency, and the furrowed surface likens the feel to the examining finger to that (to use the customary simile) of "a bag full of earth-worms."

It must not be forgotten that in adults also the lymphoid hypertrophy is found; but, as previously noted, the consistency of the deposits is firmer and they are aggregated in the middle of the vault, at the site of the so-called third or pharyngeal tonsil. The condition is really a hypertrophy of the latter structure (see Fig. 562).

Small cysts are occasionally found in the masses.

As compared with enlargements of other segments of the tonsillar ring, the principal difference here is the small amount of connective tissue. The growths are largely protected from those irritative influences which predispose to connective-tissue formation.

Symptoms.—Patients are brought to the physician with the statement that the nose is more or less stuffed up and at times discharges muco-pus. The children breathe through their mouths and snore at night. The voice has a peculiar "dead" quality or lack of resonance. The expression is stupid and the mental condition seemingly often below par. Deafness is not uncommon, and in marked cases an offensive aural discharge exists. Cough may occur and occasionally spasmodic breathing. Other possible features are nose-bleed, night-terrors, nocturnal enuresis, aprosexia, and a broadening of the bridge of the nose.

Night-sweats, chest-deformities, abnormal formation of the facial and palatal bones, defective development, and many other allied conditions have been directly attributed to lymphoid vegetations in the vault. Many of them are doubtless more properly referable to the underlying dyscrasia of which the vegetations are but a single expression.

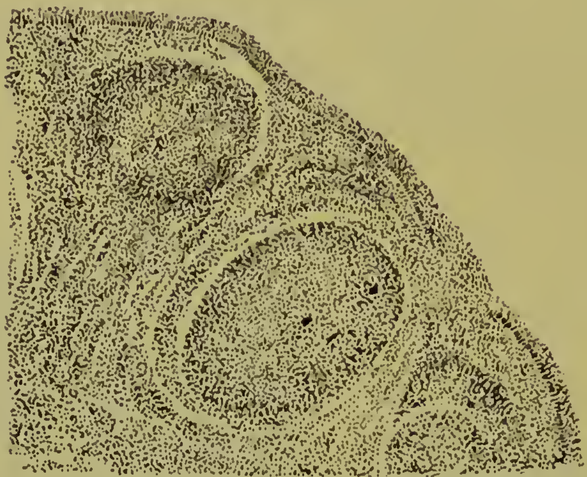

FIG. 585.—Hypertrophy of the pharyngeal tonsil (Seifert and Kahn).

Let us analyze the foregoing symptoms somewhat in detail.

The profuse nasal discharge is the result (as previously stated) not of an inflammation of the true acinous glands, but of the surfaces of the folds and clefts of the growths. The tissue is so soft and pulpy that it breaks down under the examining finger, which upon its withdrawal is covered with blood, and this latter fact alone evidences an abnormal naso-pharynx. The mouth-breathing comes from the greater or less obstruction to the passage of air through the posterior nares, through the pharynx, and thence to the lungs. The snoring ensues upon the relaxation of the soft palate, always present and naturally accentuated during sleep.

The voice-tone arises from the interference of the growths with the excursions of the sound-waves transmitted upward from the larynx. The "sounding-board" function of the pharynx is impaired. "Spring," "ninety-nine," etc. are pronounced "sprig," "nīdy-nīd." Deafness and aural discharges are sequences of rarefaction of air in the naso-pharynx, hyperemia of the lining of the Eustachian tubes and middle ear, and retracted drum-heads. There may be eventual ankylosis of the ossicles with atrophy of the tympanic membrane. Sometimes a true catarrhal inflammation is set up, changing to a purulent form.

Cough is referable to pharyngeal irritation, either from mouth-breathing or from the impact of secretion detached from the vault. Night-terrors, sense of choking, enuresis, etc., are all due to the overloading of the blood with carbonic-acid gas and the resulting nervous explosion. Grönbech found enuresis in 13 per cent. of 192 cases, with a large proportion of cures of this special symptom after removal of the vegetations. He admits a general predisposition to enuresis. Otherwise, he says, we would find it more frequently in hypertrophy than we do.

The term "aprosexia" (from a Greek derivation meaning literally "not to hold toward or to") was suggested by Guye of Amsterdam as a proper designation for the inability which many of these children manifest to concentrate their attention upon any one thing. It probably arises from a sluggish lymph-circulation at the base of the brain, which in turn affects the functional integrity of the higher centers. Retzius and Axel-Key have demonstrated the close anatomical relations between the lymph-channels of the naso-pharynx and those at the base of the brain.

Harrison Allen has called attention to a condition which he calls "adenoid disease." The obstruction is here due to a congenitally narrowed naso-pharynx. It does not excite mischief by reason of its influence on either respiration or acute catarrh, but affects directly general nutrition, and in the opinion of the author quoted is allied to acromegaly and myxedema.

Several authors report cases of torticollis coexisting with but cured by the removal of the lymphoid vegetations, and the same is true as regards epileptic seizures.

Diagnosis.—Many of these cases can be recognized at sight, the peculiar facies and open mouth at once suggesting the nature of the trouble. In tractable children the small mirror enables us to actually see the deposits. In intractable ones the forefinger of the right hand can easily be slipped up behind the soft palate and the situation of the masses accurately located. Another test (not diagnostic of this particular condition, however) is the throwing of a warm antiseptic or oily spray through one anterior naris. If the nose and naso-pharynx are clear, the fluid will escape from the other nostril with practically undiminished force.

It is, of course, possible for these vegetations to be of a sarcomatous, syphilitic, or tubercular nature, so far as their pathological structure is concerned ; but unless other and visible evidences of these respective diseases are present, our diagnosis will probably fall short of this degree of refinement. Such cases have come to light mainly from the microscopic examination of the tissue removed.

Prognosis.—Parents always inquire if vegetations will do any permanent injury if left alone. Most emphatically they will. The worst cases with their train of symptoms, called in general "catarrh," will have attracted the parents' attention, and they will consent to operative removal of the offending tissue. In the less marked cases they may regard an operation as unnecessary ; but it must be pointed out to them that even if there seems to be no immediate danger, there is great danger of permanent damage to the organs of hearing and of the perpetuation of an intractable post-nasal catarrh after puberty. Immediate dangers are the increased liability to any contagion which may surround the child, diseases from impaired vitality of the upper air-tract, defective mental and physical development, deformities in the jaws, and defective dental development.

On the other hand, there is no operative procedure in the whole domain of this branch of medicine attended by happier results than is that for the removal of lymphoid hypertrophy from the vault of the pharynx. The child is physically almost born again. Dull intellects brighten, deaf ears are unstopped, phonation becomes clear and distinct, mouth-breathing disappears. In short, the child is a new creature.

Does such tissue recur after removal? The general answer has been in the negative, provided that the operation has been thorough. F. E. Hopkins, who has investigated this question, believes that recurrence may happen even after the most thorough removal. This possibility of recurrence is not surprising when we remember that the lymphoid elements in this situation are not mere surface-deposits. They normally infiltrate all the layers of the mucosa down to the periosteum. Literally, complete removal of all lymphoid elements would therefore leave bare bone.

Treatment.—The existence of any underlying diathesis must be sought out and remedied. For general tonics cod-liver oil and syrup of the iodid of iron have no superiors. The latter should supplement every operative procedure. Customary directions should be given in regard to bathing, clothing, foot-wear, diet, etc. Especially should it be insisted upon that the child shall sleep in a room directly open to outside air.

Little value resides in topical sprays and applications. They may afford temporary relief, but it is only temporary. Caustic acids and the galvano-cautery have their advocates as destructive agents, but such measures are difficult to follow out in children. By exclusion, therefore, the question of treatment practically narrows itself down to the removal of the vegetations by some cutting or scraping method.

In children over twelve and in adults, cocain-anesthesia will suffice. In younger patients we have the choice between ether, chloroform, nitrous oxid, and ethyl bromid. If ether is used, only the primary degree of anesthesia need be induced.

Of instruments we have the finger-nail or the steel nail to be worn over the forefinger, various curettes and forceps almost without number. These are figured and all operative details described under Operations.

ATROPHIC RHINITIS.

By W. PEYRE PORCHER, M. D.,

OF CHARLESTON, S. C.

Synonyms.—Rhinitis sicca and cirrhotica; Coryza fetida; Ozena, etc.

In atrophic rhinitis, as in atrophy of other organs, atrophic degeneration of the glandular and muscular structures is found in one form or another, whether the disease occurs in the young or the old, in the plethoric or the anemic. Microscopical research amply substantiates this fact, as shown by the investigations of Fränkel, Gottstein, Krause, Hartmann, Bosworth, and others. Owing to the various phases which it presents, it has been divided by authors into several varieties—namely, mucous or simple dry rhinitis, muco-purulent or atrophic rhinitis, and ozena; but the typical form of non-ulcerative atrophic rhinitis, attended by the formation and retention of crusts in the nasal fossæ, is distinctive, and is characterized by a horrible stench, which once inhaled can never be forgotten.

The odor from syphilitic necrosed bone resembles it in some degree and is quite as objectionable; but the fetor of atrophic rhinitis has more of a musty, graveyard odor, and produces a sensation which is unlike anything else to which it can be compared. It is generally admitted that syphilis is not always a factor in the etiology of typical non-ulcerative atrophic rhinitis; but syphilitic ulceration with caries always results in atrophic degeneration of the nasal mucosa, and in the majority of instances the disease will be found combined either with syphilis, struma, or tuberculosis.

The odor varies greatly in intensity in different individuals, as well as the crust-formation, even to the complete absence of one or the other symptom; but where the fetor is marked it may safely be depended on that retained secretion will be found in some fossæ or in the accessory sinuses; and where the amount of crust-formation is very great and long retained, the fetor will usually be proportionately intense. I speak of typical non-ulcerative atrophic rhinitis because one of the most common fallacies is that the disease is always accompanied by ulceration. There is never any ulceration except when a crust has been allowed to remain so long that a raw surface is left beneath it, or where the septum is excoriated by frequent picking with the finger-nail, or as a result of syphilitic or tubercular degeneration. It occasionally happens that atrophic degeneration occurs without crusts or odor; but these cases are by no means of frequent occurrence.

Atrophic rhinitis is found so much oftener in the female than in the male that it has been held by some to be purely a woman's disease, as it develops frequently at the age of puberty and is thought to be uncommon after the menopause. This has not been the experience of the writer, however, as many of the worst cases which have come under my care have been in old women who have long passed the menopause; and it has occurred quite as frequently in men as in women. Just when the disease begins or what is the immediate cause, has always been difficult to determine from the history; as in most, if not all, cases the patients are unaware of its existence until it has become so well established and has made such inroads that it can no longer be overlooked, either by themselves or their friends. It may be found at any age from extreme youth to old age; but in the former case it is very difficult to differentiate it from the syphilitic manifestations with which it is so often combined or on which it is superinduced. The poorly nourished or those whose hygienic surroundings are very bad are the most common subjects of the disease, because of the repeated catarrhal attacks to which they are liable and the prolonged purulent discharges in which these attacks result.

Symptoms.—A typical case of atrophic rhinitis has been described as follows: The patient complains of great, often almost choking, dryness in the throat, of accumulation of mucous crusts, particularly in the vault of the pharynx, and of loss of the sense of smell; an intolerable sickening odor may or may not be present in greater or less degree. On inspection the mucous membrane is found to be dry and shiny, and the turbinals nearly or entirely destroyed by atrophy. The nasal chambers are greatly enlarged, so that the pharyngeal wall can be plainly seen by anterior rhinoscopy. The surface of the turbinals is often rough and irregular from unequal degenerations; and intense congestion from crust-irritation is generally present. By posterior rhinoscopy the pharyngeal glandular tissue is found to be almost totally destroyed, and the vault and nasal fossæ are blocked by crusts, often intensely offensive, which may be either dry or soft and mucous in character, and often completely occlude the Eustachian tubes and posterior nares. The lower pharynx presents a most peculiar and typical appearance. The posterior wall is dry, often puckered from lack of moisture, and intensely congested. The posterior half-arches appear drawn much nearer together than in their normal condition, and on pressure with the probe, the pharyngeal mucous membrane is found to be practically resting on the bodies of the vertebræ. Deeply congested and frequently abraded tissues are found on examination with the laryngoscope, and the trachea and bronchi are often also diseased.

The foul breath forms, of course, the most obtrusive symptom. Owing to the atrophy of the nerve-filaments in the olfactory region, where the degeneration generally begins, there is complete anosmia, so that the patients are entirely unconscious of the stench which they exhale; but they gradually learn to shun people. Their presence, however, is often only too apparent, even when they are at a distance, unless they are in the open air or the ventilation of the apartment is unusually good.

The trouble is generally attributed by the patients to gastritis, or the complaint is made that they never have occasion to blow the nose from one week to another. When they do, however, a large crust is generally expelled. This gives great relief to the sufferer and lessens the odor for a short time; but it recurs with full intensity as soon as the crusts re-form, and becomes more penetrating the longer they are allowed to remain. The color of the crusts varies from brown to green and yellow, and they are sometimes even black on the outside. They are generally hard in the middle, but become softer in consistency as they approach the outside edges.

The eyes and ears are often involved. The mouths of the Eustachian tubes are large and patulous, and not infrequently acute suppurations of the middle ear, accompanied by very severe pain, are caused by small particles of mucus which have been inhaled or driven in by the forcible use of the anterior or posterior nasal douche. When the abscess is complicated with or dependent upon a syphilitic diathesis, there may be a complete absence of pain, and this forms a means of differential diagnosis between an abscess due alone to atrophic disease and that dependent upon the syphilitic diathesis. Bosworth maintains "that in a given number of cases of grave impairment of hearing the number due to hypertrophic disease outnumbers those due to atrophic disease in far greater proportions than the comparative frequency of the two diseases." This is a most rational conclusion for many reasons, but especially because every tendency of hypertrophic rhinitis is to occlude the Eustachian tubes, whereas in the atrophic forms the tubes are open and patulous. Tinnitus and many other intractable forms of ear-disease are sometimes distinctly traceable to this disease. Many affections of the eyes may accompany or result from atrophic degeneration of the nose, notably phlyctenular keratitis and conjunctivitis.

Atrophic rhinitis frequently dates from one or other of the exanthemata, scarlet fever, measles, or diphtheria, or more commonly from a series of bad colds in the head. There is a certain facial expression that is almost typical of sufferers from ozena—the low flat nose with the large open nostrils. In old subjects the nose generally appears to be almost sunken in the face. There is a peculiar dry appearance about the vestibule and anterior naris. There is a complete absence of vibrissæ, with widely distended alæ, as though the patient was suffering from want of breath. This must unquestionably be caused by the large plugs of mucus, in which a small hole is often found, on which, unless they resort to mouth-breathing, the patients must depend for their supply of air until the plug is removed. So tightly do these crusts become impacted in the nares that their pressure may contribute to cause the abnormal roominess found in the nose, the turbinals are pressed widely apart, there is a complete collapse of the erectile tissue, and in some cases the mouths of the Eustachian tubes and the posterior pharyngeal wall can be inspected by anterior rhinoscopy. The mucous membrane is conspicuously pale, except around the margins of ulcerations or in localized spots of inflammation. In the incipiency of the disease the mucous membrane will generally be covered with a thick, glairy, white secretion, which constitutes a most aggravating source of annoyance both to the patient and to the practitioner. The patient keeps up an incessant coughing, hawking, and clearing of the throat in the effort to get rid of it, and the physician finds it almost impossible to free the throat and nose, even with the most persistent washing and swabbing out with antiseptic solutions, etc. It is the belief of the writer that many patients have succumbed to this disease before the diagnosis was ever clearly established. The continuous cough and irritation so lowers the vitality of the patient that death supervenes directly or is superinduced upon some intercurrent malady.

Epistaxis not infrequently occurs as a result of erosions caused by dry incrustations on the septum and elsewhere. These erosions may be so small that the point from which the hemorrhage proceeds can only with difficulty be detected. The hemorrhage may also be produced by a perforation through the septum, due to incessant picking of the nose in the effort to get rid of the crust-formation. Hoarseness is often present and the vocal function is always impaired. In the later stages of the disease the crusts break up, and small particles being inhaled set up violent spasms and incessant and aggravating cough. These small particles are often seen lying upon the vocal cords or other parts of the laryngeal interior, and there can be no question that their presence often results in the most intractable laryngeal and pulmonary inflammation.

Etiology.—Many theories have been advanced as to the etiology of this disease. Mackenzie says: "That atrophic rhinitis always appears as a sequel of a pre-existing catarrhal inflammation is rendered highly probable from a number of clinical and pathological facts. If the clinical history be accurately taken, it will point to pre-existing catarrhal process. As has been indicated above, the rapidity with which the hypertrophic passes into the atrophic form of rhinitis is proportionate in all probability to the possession of some constitutional taint, such as congenital or acquired syphilis."

Dr. Bosworth says that "a purulent rhinitis in childhood is a catarrhal process in the first year and a catarrhal process always; and that it consists essentially in an increased secretion of mucus in the earlier stages, together with rapid desquamation of epithelial cells, which, running its course as a purulent disease in from five to ten years, develops finally into what is known as atrophic rhinitis. The disease, in fact, is the first stage of so-called dry catarrh or ozena." The theory that a purulent inflammation of the accessory cavities is the cause of atrophic rhinitis was advanced many years ago by Michel, and sphenoidal and ethmoidal involvement is common.

A hypertrophied mucous membrane may be found in one nostril with atrophic degeneration in the other; but that does not prove that either condition is dependent upon the other.

One of the interesting theories of the etiology of atrophic rhinitis is that of Löwenberg, who attributed it to micro-organisms.

Auché and Brindel[1] contribute a paper to the bacteriology of atrophic rhinitis which confirms the observations of many previous students. They examined twenty cases, and their results are summed up as follows:

"1. The diplobacillus of Löwenberg has been demonstrated in all the cases of atrophic rhinitis with or without ozena in course of evolution. It was not found in old atrophic coryzas which had apparently been cured. It is not the pathogenic agent of ozena.

"2. The pseudo-diphtheria-bacillus was found eighteen times out of twenty observations of atrophic coryza in course of evolution. It was met with twice in four patients affected with old atrophic rhinitis which had been much ameliorated. It is not the causative agent of ozena. It is very probably only a saprophyte developed in the nasal chambers of patients affected with atrophic coryza, on account of changes in the secretions of the mucosa.

"3. The little bacillus of Pes and Gradenigo was only found in cases of ozena (crusts), and only in the proportion of three to twenty.

"4. Electrolysis produced no effect upon the microbial flora of our patients."

Arslan,[2] after the bacteriological examination of 24 cases, arrived at results which are equally negative so far as concerns the discovery of an organism which could be regarded as the causative agent of the malady, but he is disposed to be rather optimistic in his views as to the efficacy of the serum-treatment of ozena. He treated a number of cases with diphtheria-antitoxin, but an analysis of all his cases does not seem to me to warrant the hope that in the serum we shall find a satisfactory curative agent for this distressing malady.

Although Gradenigo has recanted his first favorable opinion of the method and there have been other discouraging reports, there seems to be considerable interest abroad among rhinologists in the outcome of experience with the method. Moline[3] reports having cured three cases of advanced ozenic atrophic rhinitis by the repeated injections of 10 cc. of Roux's diphtheria-antitoxin. He reserves his decision as to the value of the method for fuller experience, and he suggests that the curative properties may reside in ordinary horse-serum. Compaired sums up his experience with the serum-treatment of ozena as follows:

"1. At present this procedure is one which furnishes the most positive results in the treatment of ozena.

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[1] *Revue hebdomadaire de laryngologie,* etc., No. 41, 1897; Wright, *N. Y. Med. Journal,* June 4, 1898.

[2] *Archivio italiano di otologia,* vol. vi. fasc. 1, 2, 3.

[3] *Annales des Maladies de l'Oreille,* etc., April, 1897.

"2. The result is shown subjectively by the disappearance of the fetor after the second or third injection of 5 or 6 cc. of serum recently obtained and employed according to all the aseptic and antiseptic rules; and objectively by the absence of dryness in the nasal fossæ with diminution of the crusts and the increase of the nasal secretion.

"3. Objectively, a change in the color of the mucosa is noted, becoming redder, moist at times, and slightly congested and hyperemic.

"4. The crusts are less hard, dry, and extensive, and become more fluid, according as the number and dose of the injections increase.

"5. The quantity of 10 cc. proposed by Gradenigo is not free from danger, and this is so even as to weaker doses. For this reason it is necessary to use the injections in gradually increasing doses with great care.

"6. The treatment in question offers many inconveniences and dangers, but, on the other hand, it furnishes very positive results; therefore it is proper that the study of the method should be carefully pursued."

Notwithstanding the above statement, until a micro-organism is constantly demonstrated in the superficial layers of the atrophied mucous membrane and it is shown that inoculations produce the disease, we must be satisfied with believing that micro-organisms are responsible only for the characteristic odor of the altered secretions of atrophic rhinitis, in which they find a suitable medium for their growth. It is probable, from what has thus far been reported, that several microbes are capable of producing the odor when growing in the secretions.

Purulent inflammation originating in any of the accessory sinuses or resulting from a simple acute inflammation may likewise result in atrophic degeneration, with more or less complete destruction of the muciparous glands and follicles. The effect of pus on the epithelial and glandular structures, especially in the nose, need not be dilated on here; but it has been a well-observed fact that atrophic degeneration generally begins upon the middle turbinal bodies, and it has also been noted that scabs which become incrusted there and elsewhere almost always contain some particles of pus incarcerated on the under surface of them. Of course, it may be said here that atrophy may result from the simple non-use of any organ, without the presence of any inflammation, simple or purulent, to produce it. Paradoxical as it may appear, it is nevertheless true that the nares of habitual mouth-breathers or those to whom the nose is little more than an ornament of the face, instead of becoming larger from atrophy of the mucosa, become narrower and more occluded, almost as though a hypertrophic instead of an atrophic process had been established; so that it cannot be said that atrophic degeneration is in any case due to simple non-use of the organ—first, because of the fact above cited, and second, because the worst cases of atrophic rhinitis are generally found in those who live in workshops where they breathe the most foul air, sooty emanations, etc.

Atrophic rhinitis occurs quite often at a very early age. Large green crusts forming complete casts of the nose have been found in children of seven years and younger. In these cases the etiological factors of hypertrophy, dust-inhalation, etc., may be entirely excluded. This was notably the case in a child of six or seven years of age that was brought to the writer. There was no specific taint in this case, and hence there could be but one cause to which the disease could possibly be attributed—namely, a prolonged rhinitis resulting from an acute attack which had been left to run on until the nasal mucosa was almost entirely destroyed.

Polypi, malignant growths, etc., have been cited as a cause of ozena. Hereditary abnormal patency of the nostrils has also been advanced as one of the causes of ozena, because of the inability of the patient to free the nostrils of accumulated muco-pus. This is too hypothetical to be relied on;

but there is no doubt that the fetor is due to decomposition and fermentative products, because when the nostrils are cleansed in the proper manner there is an almost complete absence of fetor for many hours afterward. The theory that atrophic degeneration is nothing but a secondary stage of the hypertrophic variety has been refuted time and again by many of the most careful clinical observers, because it affords no explanation of the ozena of early childhood; and the dry rhinitis of later life is not always preceded by hypertrophy, and hypertrophy does not always terminate in atrophy. The theory of Michel that the disease is due solely to purulent discharges flowing from one or other of the accessory sinuses met with much favor for some time; but this also has been refuted, because in some instances the accessory sinuses were not found to be involved or any discharge flowing from them.

Diagnosis.—In regard to diagnosis, there should be no difficulty, as the intense fetor at once makes itself known, and in the cases where this symptom is reduced to a minimum the large roomy nostril, together with the characteristic physiognomy, at once proclaims the nature of the malady. I cannot agree with the authors who make separate subdivisions of simple vascular collapse of the turbinals, mucous or simple dry rhinitis, ozena, etc. I am inclined to believe rather that these will be found to be only different stages of the same disease. This also applies to ulcerations which are found in some so-called non-syphilitic cases and not in others.

The ulcerations will generally be found in those cases in which there has been not only an entire neglect of treatment, but in which the patients have had no relief from the sources of irritation which originally started the disease, and in which the crusts have been retained so long that the mucous membrane has broken down and left the tissues abraded.

The crusts in lupus vulgaris may be mistaken for those of atrophic rhinitis, but lupus generally attacks the outside of the nose as well as the inside; and when the inside is alone involved the crusts adhere so closely that they cannot be removed without hemorrhages and the fetor is never so intense as it is in ozena. In ordinary cases of atrophic rhinitis the crust will be found lining the mucous membrane of both nares. It may completely fill the nasal chamber, being perforated in places for the air to pass through; and when blown out it will show a complete cast of the interior.

In syphilitic ulceration the ravages of the disease are far more general than in lupus and the sequestrum rapidly forms, which, together with the history of the case and the peculiar fetor, may make the diagnosis very clear. The presence of rhinoliths can only be determined with the aid of the rhinoscope and the probe. Tubercular ulceration may be mistaken for ozena, especially in the incipiency of the disease; but here again we must rely on the history, the general appearance of the patient, and the microscopical examination.

Pathology.—Opinions vary so much in regard to the pathology of atrophic rhinitis in accordance with the various theories of the etiology of the disease, that it is difficult to arrive at any definite conclusion in regard to it. It is generally admitted that it is similar to that of atrophic degeneration in any other organ—*i. e.*, a gradual wasting away of the different layers of mucous membrane and the conversion of their individual elements into fibrous connective tissue. The walls of the erectile spaces are converted into dense fibrous bands, which in contracting obliterate the erectile cavities. This fibrous degeneration may be confined to the deeper layer and the epithelial layer be intact; or the epithelial layer may be destroyed, while the deeper layers are less involved. The limits of this article make it impossible to go into the minute microscopical appearances of this condition; but this can be found in any of the text-books on the subject.

Prognosis.—It is beyond question that this disease is one of the most intractable to deal with in the whole field of medicine, and from the very nature of the case it is held by a very large number of most eminent authorities to be incurable. There are still a large number, however, as will be seen later, who believe that the mucous membrane can be so changed by judicious use of stimulants, antiseptics, constitutional treatment, etc., that a virtual cure is brought about; and in the light of the most recent investigations it is the opinion of the writer that this latter conclusion will be found to be correct.

Treatment.—It is apparent, then, as has been stated by some writers, that atrophic rhinitis is not a disease *per se*, but is the result of any inflammation, acute or chronic, specific or non-specific, whether excited by exposure to cold or continuous inhalation of irritating dust, vapors, etc., which ends in a purulent discharge, and which may or may not involve the accessory sinuses, but is sufficiently prolonged to wash away the epithelium and destroy the nasal mucosa. If this is true, what measures should best be instituted for the relief of the patient, and what hope have we that the formation of scabs may be stopped?

In response to an article by the writer, this subject was very fully discussed at the meeting of the American Laryngological Association in 1896, and again it was made the special subject of discussion at the annual meeting in 1897, and a great many varieties of treatment were suggested. The following *résumé* of remarks will give some idea of most advanced views of the treatment of this disease (see also page 885):

Dr. C. C. Rice expressed his belief that the disease was intimately dependent upon some constitutional taint or unhealthy occupation or manner of living. He therefore urged the necessity of giving patients out-of-door work with good hygienic and sanitary surroundings. He recommended a combination of 75 per cent. compound stearate of zinc with boric acid and 25 per cent. compound stearate of zinc with alum. This powder should not be used after the discharge has been stopped and congestion controlled, as it is too drying. In the markedly congestive forms of atrophic rhinitis seen in immoderate cigarette smokers and alcoholic drinkers this powder is a valuable one. It goes without saying that we should not promise any benefit from any form of treatment unless excessive smoking and drinking are given up.

Dr. Wright recommended mild stimulation with a weak solution of thymol.

Dr. Delavan concurred with Dr. Wright, and recommended electricity for the same reason.

Dr. Vanderpoel had used diphtheria-antitoxin based on the similarity between the Klebs-Löffler bacilli of diphtheria and those found in atrophic rhinitis, and in one case there was no return of the crusts which the patient had had before the attack of diphtheria.

Dr. Logan laid stress on the necessity of establishing free drainage from the accessory sinuses, so as to stop the continual discharge of pus over the middle and upper turbinals.

Dr. Casselberry advised that patients should select the warmer, moist, and salubrious climate of the Southern seashore rather than the dry regions of the West.

Dr. Mackenzie recommended weak solutions of bichlorid of mercury rather than strong antiseptics. A form of stimulation in the shape of massage has been strongly recommended by Laker of Vienna. Massage may be applied to the nose either by the aid of an electrical vibrator or simply by titillating the parts with a probe armed with a pledget of cotton.

The Germans and Italians recommend bichlorid of mercury strongly on the assumption that the disease is due to the presence of bacteria. Koch and Löwenberg claim great benefit from a solution of 1 : 2000 or 1 : 4000, applied with a spray or brush. Cardonne of Naples and Marano also advocate the same treatment. Belfanti has used the diphtheria-antitoxin with great benefit in ozena; and other observers have used the same treatment, but not with uniformly good results.

Dr. George Stoker of London warmly recommends the use of oxygen-gas in this affection and chronic aural suppuration. The nose or ear is first thoroughly cleansed with warm water and the gas is then applied from four to six hours daily, with intervals of one half hour. The efficacy of this plan of treatment is beyond question where free outlet is given to all pus-cavities and free ingress of oxygen is allowed.

Where a specific element is present mercury should be pushed to the extent of moderate salivation. A patient recently under the care of the writer became severely salivated, with the result that the formation of crusts as well as the severe headaches which had occurred daily before the treatment has ceased entirely and the patient considers himself cured. He has experienced no ill effects whatsoever from the salivation, and denies absolutely any venereal infection; nevertheless, the atrophic condition has undoubtedly been materially benefited. He used locally also a spray, as follows: ℞. Glycerin pur., ℥ij; sodii bibor., ʒv; aquæ destillatæ, ℥j. The nose was thoroughly sprayed with this solution three times a day. The use of the galvanic current applied locally, first recommended by Shurly of Detroit and afterward by Delavan and Hartmann, has produced excellent results.

A great many drugs have been used for their irritating and stimulating effects. Among these may be mentioned iodoform, iodol, aristol, salicylic acid, camphor, iodin, perchlorid of iron, tannin, alum, opium, 25 per cent. trichloracetic acid, etc. The writer has used with much success a solution of iodin, glycerin, and potassium iodid applied on a cotton pledget high up in the vault of the nose. This produces a very profuse discharge of mucus, which washes away the crusts and after a time appears to prevent their formation.

The use of caustics, the electric cautery, chromic acid, etc., should never be indulged in because of their injurious effect on an already attenuated membrane. Almost every drug in the Materia Medica has been tried in one way or another to cure this disease, and they have been given up because they proved either entirely valueless or only palliative. Dioxid of hydrogen was at one time highly extolled, but has been abandoned because it leaves the mucous membrane as dry as ever. Oily solutions in combination with various drugs act as excellent stimulants and protectives, but do not accomplish much in the way of cure.

In conclusion, the writer would suggest the following plan of procedure: A rigid examination should first be made to determine if there is any discharge of pus from the accessory sinuses, any sign or possibility of specific taint, any history of tubercular or diphtheritic disease, and the general hygienic and sanitary surroundings of the patient should be carefully investigated. Should a pus discharge be found from any of the accessory sinuses, free outlet should be given to it and the sinus should be carefully washed out with hydrogen dioxid and dusted with some antiseptic powder. If in any case there is the least likelihood of a specific complication, mercury and opium with mercurial inunction should be pushed until mild salivation is produced. It has been the experience of the writer that the combination of mercury and opium has a much more rapid and satisfactory effect than iodid of potash,[1] even when given in very large doses. The patient should be ordered to keep the nose thoroughly cleansed always with Seiler's solution or a spray of glycerin and biborate of soda or some other mild stimulant used three times a day. If the patient has had diphtheria or the crusts still persist, diphtheria-antitoxin may be administered and a solution of bichlorid of mercury (1 :2000) be sprayed daily. The patient should be directed to live out of doors as much as possible, and his general health should be built up with tonics, cod-liver oil, etc.

The limits of this article entirely forbid further elaboration of this subject. Suffice it to say that the best results will be obtained when the patient is instructed how to maintain thorough cleansing so as to promote adequate nasal respiration, as well as the healing of all ulcerations, proper drainage, and the restoration of the normal mucous lining membrane as far as possible. He should have plenty of fresh air and sunshine, as well as absolutely hygienic surroundings. In some instances a visit to the seashore or some mineral springs will exert a marked influence for the better. J. N. Mackenzie advises that "as little liquid nourishment should be taken as is compatible with the comfort of the individual."

The ingestion of large quantities of liquids is to be deprecated, as well as alcoholic beverages of any kind, unless taken in great moderation. Healthy out-door exercise, combined with the observance of the ordinary rules of health, will generally so moderate the worst features of the disease as to render the patient comparatively comfortable, if not entirely relieved.

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[1] In syphilitic cases ulceration and sequestrum-formation may be furthered by the mercurial, when the iodid will give as prompt and lasting cure without such loss of substance.

DISEASES OF THE ACCESSORY SINUSES OF THE NOSE.

By ROBERT CUNNINGHAM MYLES, M.D.,

OF NEW YORK CITY.

THE accessory sinuses of the nose are cavities in the bones of the head and face that connect with the nasal fossæ by one or more narrow apertures. There are three bilateral single sinuses—the antra of Highmore, or maxillary sinuses, the frontal sinuses, the sphenoidal sinuses, and two bilateral groups of sinuses, the anterior and posterior ethmoidal sinuses.

ANATOMY.

The maxillary sinuses are situated on both sides of the face, between the orbits and upper teeth (see Fig. 545); their average measurements are about 27 millimeters through the center, both vertically and antero-posteriorly. They have an oblong or fissure-like opening into the middle meatus of the nose, about its middle third. Accessory openings posterior to the hiatus are common. Occasionally the roots of the molars project like small cones from the floor of the sinus, and frequently there are partitions and membranous bands, one-fourth to one-half an inch high, dividing the floor and walls into compart-

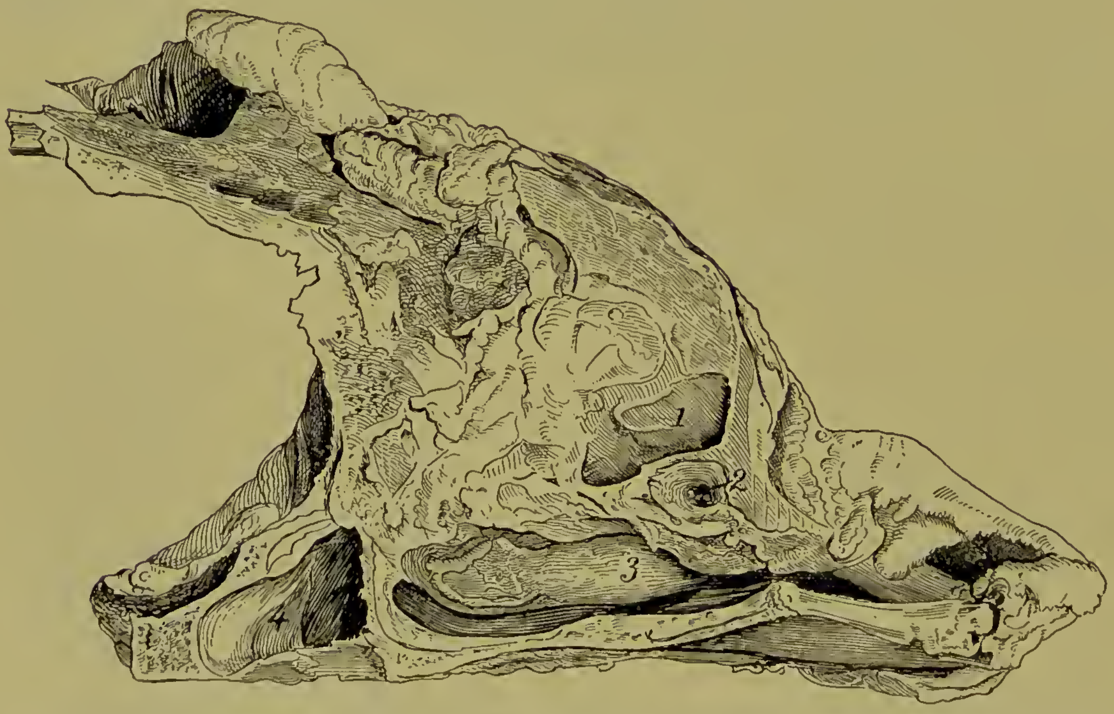

FIG. 586.—Horizontal section through the nasal cavities from above: 1, cavity of antrum of Highmore; 2, naso-lachrymal duct; 3, middle turbinal; 4, sphenoid cell. (See also Plate 10.)

ments. These are often regarded by observers as pathological formations, but I believe that they are normal. The walls of the canine fossæ and the inner or nasal wall, from one-third of an inch above the floor, are very thin, excepting that part which gives an attachment to the inferior turbinated bone. Fluids of low specific gravity will sometimes flow from the frontal sinus, down through the infundibulum, into the antrum of Highmore. This is important, as it shows that the antrum may serve as a pus-reservoir for the inflammatory products from the frontal sinus or anterior ethmoidal cells. The ethmoidal cells are situated between the nasal process of the superior maxillary and lachrymal bones and the frontal sinus in front; the sphenoid and palate bones behind; the sphenoid, cribriform plate, and frontal bones above; and the os planum, lachrymal, sphenoid, and superior maxillary bones on the outer side. The inner side is bounded by the space from the cribriform plate to the middle third of the middle meatus in front and to the attachment of the middle turbinated bone behind. (Fig. 543 shows the ethmoidal cells partially exposed.) They are separated by an unbroken partition into anterior and posterior cells. Sometimes the anterior cells communicate with the infundibulum or frontal sinus direct. The anterior cells drain by an opening in the median wall of the ethmoidal bulla, and frequently by another opening into the superior meatus. The sphenoidal cells are best described as being in the body of the sphenoid bone; they are separated from the posterior ethmoidal cells by a common wall, and discharge their contents through an opening in the upper anterior wall. (Fig. 548 shows right and left cells as they cross the median line.) The frontal sinuses are situated in the frontal bone, above the inner canthus of each eye. Their walls are made up by the frontal bone, excepting a part of the floor, which is formed by the ethmoidal cells and the projecting portion of the nasal process of the superior maxilla (see Fig. 547). These cavities are irregular in size: in the average sinus the perpendicular and transverse diameters are about one inch in their longest axis. The central antero-posterior diameter measures about three-eighths to one-fourth inch; it is not uncommon to find one large and one very small cell in the same head. The large cells usually extend toward

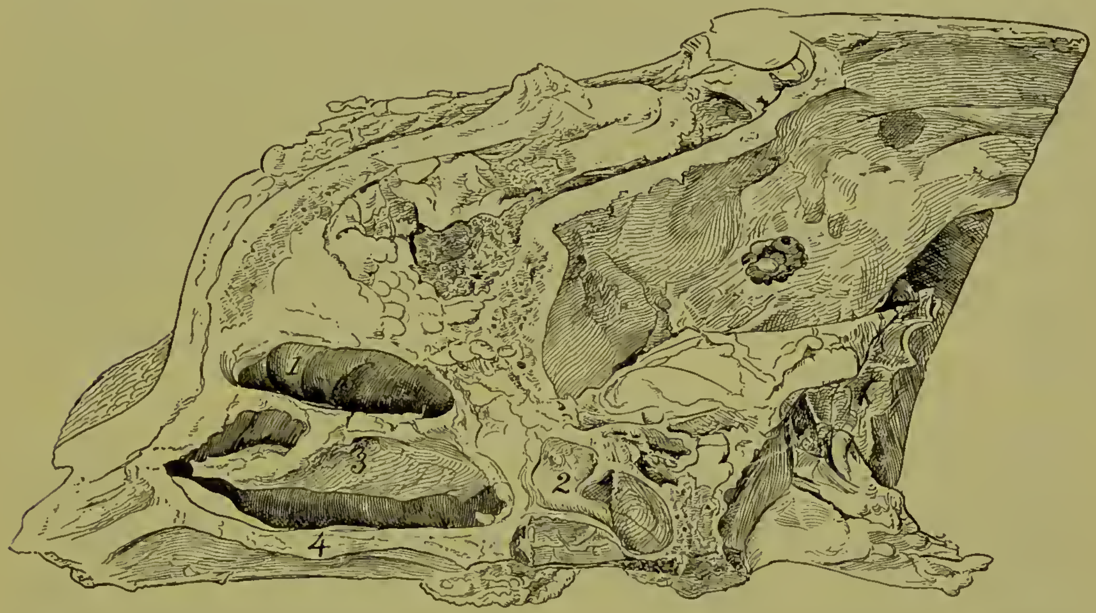

FIG. 587.—Horizontal section through the nasal cavities: 1, cavity of antrum of Highmore; 2, sphenoid cell; 3, inferior turbinal; 4, septum.

the temporal region, from one to three millimeters beyond the orbital notch, and they discharge their secretion through an irregular tortuous canal, the infundibulum. They are divided by a bony wall, which is rarely central and occasionally perforated (see Figs. 544 and 548).

PHYSIOLOGY.

Although the physiology of these cells is not definitely settled, an analysis of their function points to the conclusion that they are intended to supply warm air and moisture for respiratory purposes, and also probably to act as resonators for modifying certain qualities of the voice. When we consider that about 400 cubic inches of air are inhaled per minute, which should be warmed to a temperature as near 98.5° F. as possible, and that this same air should be charged with vapor nearly to the point of saturation, I cannot conceive of a more satisfactory arrangement than these cells afford. During respiration the apertures, including the naso-lachrymal ducts, have a tendency to dilate, while during expiration they partially close. At the beginning of inspiration, the partial vacuum produced takes a part of the latent air from within the cells, and the velocity of the inspired current further draws from them. Toward the end of the inspiratory act, new air enters the cells to fill the partial vacuum, aided by the natural law by which warm air is displaced by cold. On expiration, the *vis à tergo* pressure partially closes the cells. The to-and-fro currents of air constantly draw the tenacious mucus from the cells, overcoming the adverse conditions of small openings and the laws of gravity.

EMPYEMA OF THE MAXILLARY SINUS.

Etiology.—Distinguished specialists have written a great deal within the past few years concerning the cause of pyogenic conditions within the antrum of Highmore; and they are about equally divided on the question whether disease of the nose or the teeth is the more frequent causal factor of disease. My own experience in the chronic cases is that the teeth and nose are about equally responsible for the purulent condition. Many of my worst cases were caused by fillings placed in teeth with very large cavities where the nerves were either exposed or dead. Suppuration had evidently occurred in the root-end; the pus had discharged itself, with little resistance, through the thin bone lying between the top of the alveolus and the floor of the antrum, and from that time the tooth had not given the patient any pain nor the dentist any concern. But the patient had been trying nearly all of the patent catarrh-remedies, and had been treated by different specialists for nasal and post-nasal catarrh. A few cases seemed to be caused by alveolar periostitis, caries, and necrosis, which had been originally started by a decaying tooth. The majority of the cases of nasal origin began with polypoid degeneration. In some of my patients their septa were so far deflected in the upper middle region that the middle turbinal bodies were pressed firmly against the hiatus; the secretions had been retained under putrefactive and fermentative conditions, and had produced chronic inflammations of the membranes and bones, and probably necrotic areas. Influenza, la grippe, or acute inflammations of almost every kind appear to produce empyema when the swelling is so great as to close the normal opening, especially by pressing the upper and inner valve-like lip of the hiatus outward against the semilunar partition. Atrophic rhinitis, syphilis, tuberculosis, tumors, and foreign bodies occasionally cause suppuration in the antrum.

Symptoms.—In cases of acute empyema with complete occlusion the pain is extremely severe, and there is a feeling as though the antrum would rupture from the intense pressure. In four of my suppurative cases with complete stenosis the pain ceased immediately after the evacuation of the pus. In those instances where the acute and subacute catarrhal process either occurred simultaneously with nasal cold or extended into the antrum by continuity there was a slight fulness and a sensation of stuffiness in the region beneath the eye, together with a thick muco-purulent discharge into the middle meatus beneath the bulla, which usually stopped within from three to six weeks. The chronic cases all had the symptoms of so-called post-nasal catarrh, and in the majority of them the mucus and pus were discharged also through the anterior nares. Certain patients complained of the fluid running downward over the upper lip whenever the head was inclined forward; others complained of asthma, tubal stenosis, tinnitus aurium, and impairment of hearing, which were relieved after an operation or by irrigation of the antrum. In my series of cases pain was the most irregular and deceptive symptom of all. Frequently it was entirely absent; at other times it would occur in either the frontal, maxillary, temporal, or occipital regions, or in two or more of them.

Pathology.—I have classified the usual pathological conditions under eight subdivisions, as follows, representing the pathological states approximately as I have observed them in my cases:

I. Acute catarrhal, suppurative, and infectious sinusitis, without complete stenosis of the normal outlet.

II. Acute catarrhal, suppurative, and infectious sinusitis, with complete occlusion of the normal outlet.

III. Subacute and chronic catarrhal and suppurative sinusitis, with moderately obstructed opening, with or without decayed puro-mucoid débris.

IV. Polypoid degeneration.

V. Alveolar periostitis and periodontitis, attended by suppuration, caries, necrosis, or other pathological changes at the root-end.

VI. Atrophic rhinitis.

VII. Tumors and foreign bodies.

VIII. Syphilis.

Acute cases without stenosis are very common. The mucous membrane of the nose and cavity is usually congested at first, and then it begins to swell, and continues to do so until it is several times its normal thickness. At this stage it usually throws out a thick muco-purulent secretion; the discharge gradually ceases within from three to six weeks, and the membrane is left a trifle thicker, having undergone slight hyperplasia. In the completely stenosed cases, where neither nature nor surgery relieves them, necrosis of the soft tissues usually occurs, and occasionally the bone is involved in the same process.

In the subacute and chronic catarrhal and suppurative cases, where the opening is moderately obstructed, the mucus frequently becomes partially inspissated and forms a lump, which enlarges by accretion and acts as a foreign agent, causing a bacterial development. The corroding by-products of this frequently destroy the surfaces of the mucosa and start small ulcerated areas, which, if not cured, extend in time to the periosteum, and often to the bone itself.

Polypoid degeneration extends from the ethmoid, or has its origin upon the antrum-membrane. In its early stages this peculiar condition may be classed as watery edema. If it occurs on the lateral or upper walls of the cavity, and remains more or less flat or mammillated, there is a possibility of its returning to its normal state under favorable conditions; but if it once becomes pedunculated it seems to lose this power of self-restoration. Caries, necrosis, and burrowing periostitis in the molar or bicuspid roots frequently extend through the floor of the bone and burrow in a fistulous manner beneath the periosteum, elevating it and frequently leaving the entire membranous floor floating in muco-purulent matter. A rupture may take place through this membrane at a distance from the injured bone and discharge itself into the nose. The membrane becomes very thick and granular, and débris from the mucus, pus, and bone degenerates in the cavity. The atrophic process, which is the consequence, in my opinion, of suppurative rhinitis in early childhood, invades the antrum, frequently destroys the epithelium and the serous glands of the membranes, and leaves a sclerosed membrane which secretes a semipurulent matter; this, in turn, degenerates in the warm cell and issues through the normal opening into the nose, where it is formed into crusts by the inspired air.

Tumors, especially sarcomata, may form in the antrum and simulate empyema. Syphilis usually attacks the antrum-walls by the formation of gummata; while at rare intervals the germs of scarlet fever, measles, tuberculosis, and diphtheria invade the antrum, as do aspergilli and other fungi.

Diagnosis.—A unilateral pus-discharge from the nasal cavity is by far the most suspicious symptom of empyema of the maxillary sinus. On rare occasions this unilateral pus- or muco-pus-discharge is only made manifest posteriorly. On the other hand, polypoid degeneration, which, in my experience, is next in frequency to the irritation caused by decaying teeth in causing antrum-trouble, is usually bilateral. The classical symptoms as laid down in the older books are usually wanting, save in the acute stenosed cases. The frequency and urgency of diseases of the antrum have led us to abandon the consideration of a great deal of the circumstantial evidence upon which formerly so much stress was laid, and we make small delay in trying to obtain positive evidence at once. This is usually secured first by inspection of the middle meatus. If pus is detected beneath the bulla ethmoidalis under the middle turbinal body and the hiatus semilunaris, we know that one of the three cavities is diseased—the anterior ethmoidal cells, the frontal sinus, or the antrum of Highmore. After cocain has been applied to the membrane and pus is found, a cotton-applicator should be used to wipe it away, and, if pus then exudes from beneath the middle turbinal body and on the lateral side of the bulla ethmoidalis, it of course comes from the anterior ethmoidal cells. If, after wiping it away and placing the patient on a lounge, with the top of his head near the floor, pus comes from the hiatus, the evidence is almost positive that its source is the antrum. In those cases in which the pus is liquid in character it will flow readily into the nose and will have a more or less offensive odor. If, however, the pus is very thick and much intermixed with mucus, it will sometimes merely protrude through the opening. In the frontal sinus cases I have usually been able to detect the pus at the very uppermost anterior part of the hiatus. Usually it is well, even after the pus discharges with the head in a downward position, to introduce a curved irrigation-tube into the hiatus, and inject warm water into the cavity; if this is successfully done, we are almost invariably rewarded with the evidence of pus in the returned fluid. In those obscure forms of latent empyema, the first evidences of their existence is usually shown by the electric light (Plate 14). Although this procedure is not infallible, it is of great value in the hands of one who knows how to employ it. A pus-discharge

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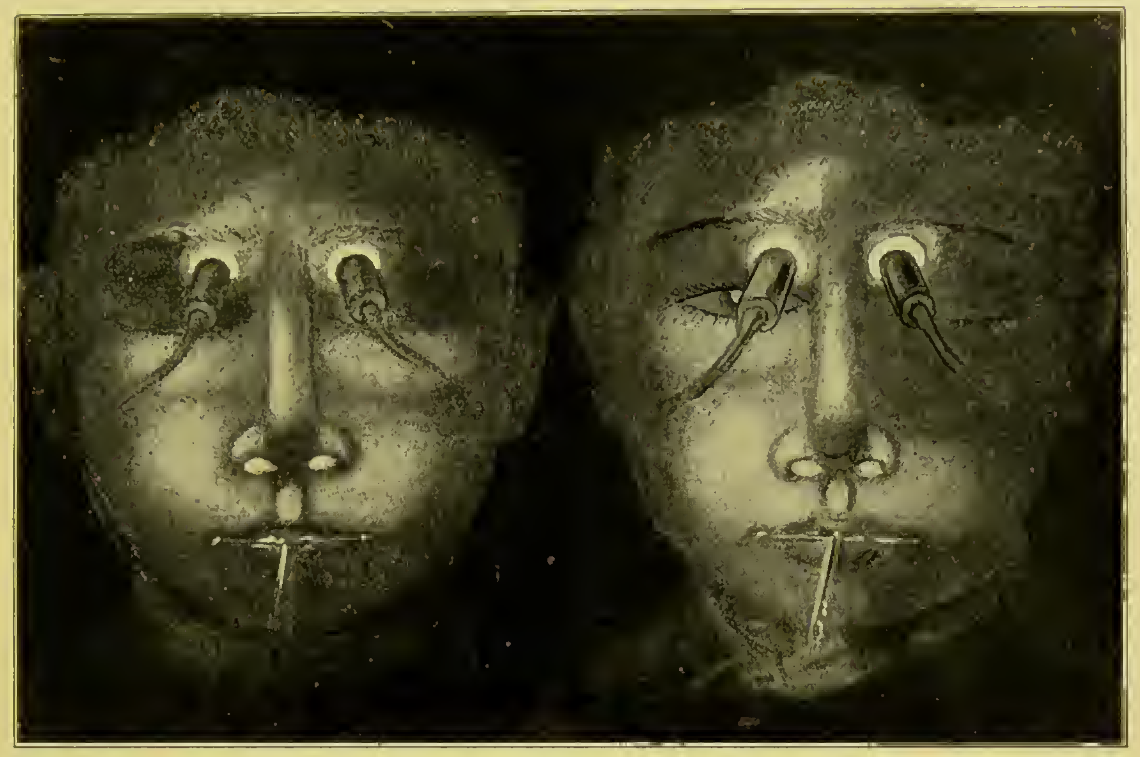
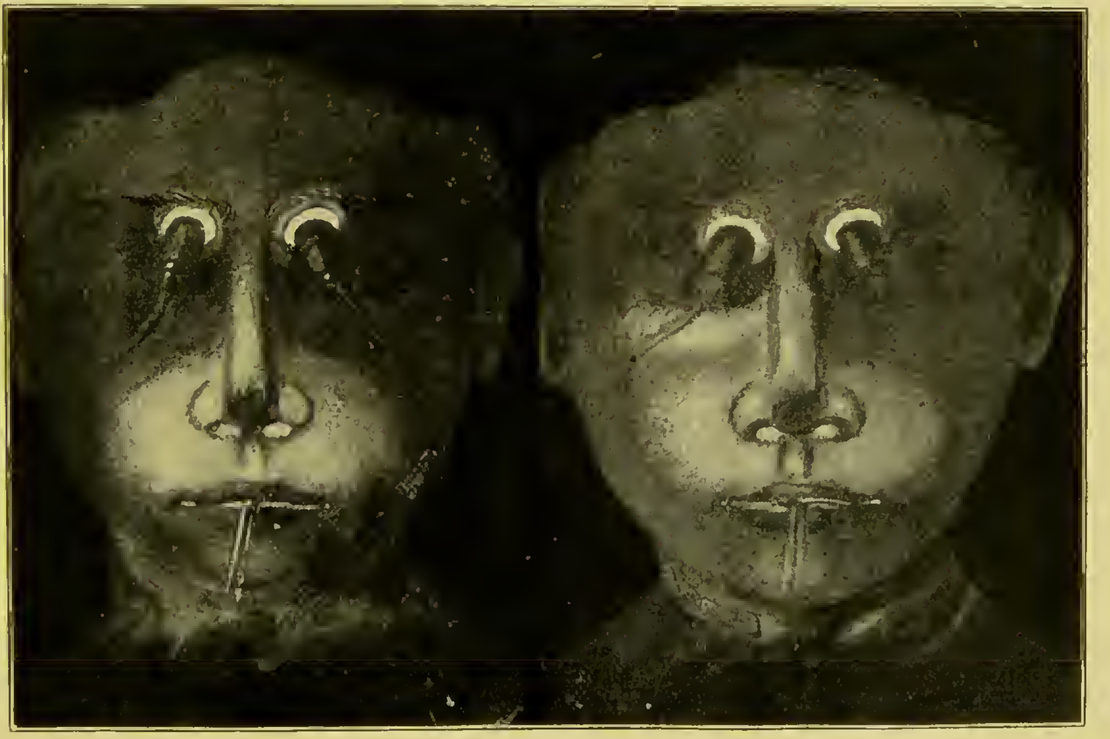
PLATE 14.



I. II.



III. IV.

FIG. I.—Transillumination of both maxillary antra by electric light in mouth, and of both frontal sinuses by lights under the orbital margin.

FIG. II.—Failure of transillumination of antrum and frontal sinus on the left, while both are lighted, and the pupil also, on the right.

FIG. III.—Failure of illumination complete for frontal and maxillary sinuses of both sides.

FIG. IV.—Only the right maxillary antrum is illuminated, while both frontals remain dark.

on one side, with a dark umbra beneath the corresponding eye, is almost conclusive evidence; yet, to make assurance doubly sure, I nearly always remove some of the pus from the antrum, either through the natural opening with the silver irrigation-tube or by means of the trocar and cannula passed through the antrum-wall in the middle meatus, just below and posterior to the hiatus.

In a few of my cases even these tests failed to demonstrate positively the pathological state within. They were cases in which the antrum was full of polyps, and in most of them there was a thick, tenacious mucus with occasional hardened lumps. The irrigation-fluid simply passed over the polyps. Puncture through the bone of the canine fossa or through the alveolus of the tooth has always seemed to me too serious a procedure to be justified for merely diagnostic purposes. The small trocar and cannula (Fig. 588) passed through the middle meatus, below the posterior end of the hiatus, where there is either very little or no bone, causes but little pain and apparently no after-disturbance. Tenderness on pressure and dulness of percussion may occur from periosteal irritation or may be due to the smallness of the antrum; but they have little significance, except as they may concur with a train of symptoms, to make the diagnosis by exclusion.

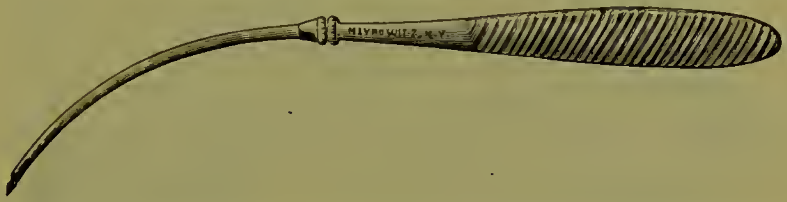


Fig. 588.—Curved trocar and cannula for entering the maxillary antrum.

Prognosis.—Diseases of these sinuses rarely cause death directly; but they frequently make life miserable. The dangerous cases of antrum-trouble which I have seen have been those in which the orbital plate was broken through by the intense pressure of the confined gases and fluids; and a few cases are reported in which the pus, burrowing through the orbit and ethmoid, has extended to the brain. In nearly all of the acute and subacute cases resolution takes place within a few weeks. If a case has existed over a year with a history of constant muco-purulent discharge, disclosing, when the cavity is opened, carious and necrotic bone, with destruction of a considerable area of the mucosa, the prognosis in regard to an early cure is unfavorable, as it usually takes several months or a year or two for the tissue to regain, even approximately, its former state. I have found cases of necrosis of the septa of the superior maxillary bone and general polypoid degeneration of the mucous membrane of the cavity the most obstinate in treatment and unfavorable in prognosis.

Treatment.—The best procedure in treating these cases will be determined by the pathological state and by the history of each case. Acute and subacute cases, not of dental or polypoid origin, can usually be readily cured by restoring the nasal mucous cavities to their normal state, and by irrigation of the sinus through the natural openings. In cases of dental origin the offending tooth should be removed; and, in those of recent date, the tissues should be let alone for a few weeks in order that they may have an opportunity to resume their normal condition, the causal factor of disease having been removed. If the trouble has existed for more than six or ten months and there is a decided odor from the antrum, with evident carious and necrotic trouble at the root-end, I advise immediate penetration by making an opening, about 5 or 6 mm. in diameter, through the alveolus-floor. Irrigation with disinfectants should be passed through with the regulation tubes and syringes. If the internal walls appear on probing or curetting to be in an extremely degenerated state, with serious carious and necrotic conditions of the bone, I think that the safest and most effective operation under these circumstances consists in a large opening into the antrum through the canine fossa and the anterior lower border of the malar ridge.[1] This opening should be from 10 to 15 mm. in diameter; the cavity should be carefully curetted, and in certain cases a counter-opening (Fig. 589), at least 8 to 10 mm. in diameter, should be made through the inferior meatus-wall into the nose. I have operated by cutting off the inferior turbinal and trephining through the inferior meatal wall, and have also cut into the lower border of the hiatus in the middle meatus. The cases in which I did this were so extensively and seriously diseased that I did not get as good a result as I had anticipated, chiefly because I could not curette the walls through this intranasal perforation. The after-treatment should consist of aseptic and antiseptic irrigations, and in certain cases keeping the canal open by means of rubber (Fig. 590) or silver tubes, with occasional careful curettage of the necrotic and granular surfaces and the insufflation of boric acid and of iodoform in certain cases where there is frequent accumulation of foul-smelling pus. I have found the injection of a drachm and a half of liquid albolene, containing 3 to 10 grains of iodoform, left in the cavity, to afford marked and decided relief.

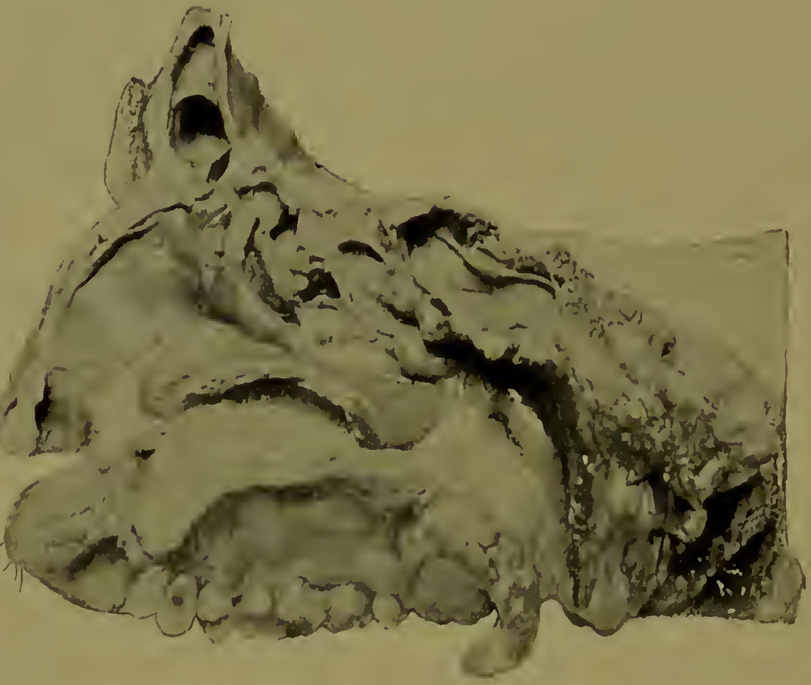


Fig. 589.—Removal of anterior two-thirds of inferior turbinal to gain access to the antrum through the outer nasal wall.

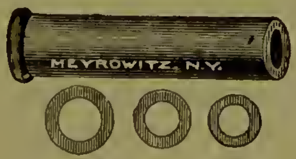


Fig. 590.—Drainage-tubes for antrum.

Class I.—The cases of *acute nature without stenosis* are very common, and usually last from three to six weeks. They come on after the manner of an ordinary cold in the head, followed within a few days by very disagreeable feelings of fulness, oppression, and dulness; in some cases a certain amount of headache exists, or toothache, and a dull feeling is present in the ears. This stage is relieved by a copious flow of muco-pus. During the course of these cases the ordinary treatment for a severe cold is the best. Most individuals who are subject to this condition have from two to four attacks during the year. The rational treatment is one of prophylaxis, which consists mainly in reducing and removing the intumescent and abnormal tissues within the nose, which should be done during the intervals of the attacks.

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[1] [The operator must be prepared for severe hemorrhage in rare cases.—Ed.]

CLASS II.—*Acute Catarrhal, Suppurative, and Infectious Sinusitis with Stenosis.*—These cases, besides requiring the ordinary treatment, demand the evacuation of the retained secretion at once. A limited amount of a saturated solution of cocain should be applied to the parts around the natural opening, and a persistent effort should be made to enter the cell with a tube, or, failing in this, penetration with trocar and cannula should be made, and the cavity should be carefully aspirated and irrigated. As soon as its patulency is restored the patient recovers rapidly. These cases call for the same treatment during the intervals as that described for Class I.

CLASS III.—*Subacute and Chronic Catarrhal and Suppurative Sinusitis, with Moderately Obstructing Stenosis, Thickened Mucosa, with or without Retained Decaying Puro-mucoid Débris.*—This class of cases is the most fruitful source of post-nasal catarrh, and is rather difficult to diagnose accurately. The symptoms rarely indicate the latent pathological condition sufficiently to warrant the operative procedures necessary for a proper diagnosis or treatment. In these cases attempts should be made to irrigate through the natural openings. In certain cases removal of the anterior end of the middle turbinal facilitates this procedure, and frequently we are rewarded with a cure or decided relief. It is taken for granted that in all classes of cases any abnormal intranasal conditions should be rectified. When these cases resist the irrigation-treatment and are of sufficient importance, a counter-opening should be made in the cell-walls and proper curettage and drainage should be carried out.

Mrs. C., aged thirty. Acute empyema; sent for me to visit her. Complained of great pain and fulness which came on with a cold in the left jaw, which was swollen and tender. The hiatus was closed by tumefaction of all the tissues near the part. After applying cocain-crystals, I washed out the antrum through the natural opening; muco-pus flowed out with the boric-acid solution; immediate relief from the severe pain followed, and the patient gradually recovered.

Miss L., aged twenty-six, had been suffering for several days from severe pain and oppression in the right side of the face, with a sensation as though the face and orbital cavity would burst. Her septum was deflected with an ecchondrosis; the turbinals were much swollen, and transillumination produced an umbra under the right eye. I reduced the intumescent tissues with cocain, and found the tissues about the right hiatus swollen and papillomatous in appearance. On introducing one of the smallest silver tubes the confined pus escaped with the irrigating fluid, which gave her immediate relief. I removed by snare a fungating papillary growth, about three millimeters in diameter, from the internal margin of the hiatus. After several irrigations at three days' intervals the cavity gradually returned to a normal condition.

Mr. A. W., aged fourteen, consulted me in May, 1892. Complained of (in his own words) "Very bad discharge from nose for the last four or five years, which consists of pure matter. Sometimes there is a buzzing noise in the head on waking in the morning. A bad smell from the nose." There had been a muco-purulent discharge with unpleasant odor, mostly from the right side, for the past three or four years.

Rhinoscopic examination showed the septum deflected to the left with an ascending oblique ecchondrosis. The septum was deflected to the right superiorly, pressing the middle turbinal body outward; pus mixed with mucus was issuing from the right hiatus. He had excessive hypertrophy of all the turbinal tissues, and also of the third and faucial tonsils. The electric light produced a light spot beneath the left eye and an umbra beneath the right. I reduced the hypertrophy of the turbinals with the electric cautery and chromic acid, and irrigated the right antrum through the natural opening two or three times a week for a few months.

The patient gradually improved, pus ceased to flow, and the electric light produced the light spot beneath both eyes.

Class IV.—*Polypoid Degeneration.*—This class furnishes by far the majority of the operative cases. Woakes, Bosworth, Casselberry, and others have well described them and their treatment. Large counter-openings, packing, careful and repeated curetting, good drainage, and irrigation are the essentials for successful treatment.

Class V.—*Odontic Periostitis and Periodontitis, Sometimes Terminating in Caries and Necrosis.*—It is universally conceded that the offending tooth in this class of cases should be removed, and, if the case be of long standing, the cavity should be opened, carefully curetted, and dressed. Formerly, following the advice of many dentists and surgeons in these extensively necrosed cases, after the tooth had been extracted, I drilled upward through the socket; but the after-history of many of such cases has caused me to regret it. The principal objectionable features are: the distance through the bone to the floor of the antrum; the dense thick tissue of the gum; the difficulty experienced in curetting, the long walls of the opening preventing the proper play of the handle of the curette; the easy entrance of food into the antrum, and the necessity of plugging the tube, when one is worn for drainage, while eating. I take it for granted that every one would prefer the lower anterior border of the malar ridge for penetration in all cases where the first molar tooth has been absent for some time. The most serious obstacle which I have met with is the decided objection of the patient to losing a tooth.

In nearly all extensively diseased cases, where some other operation was performed in place of the one through the malar ridge, the patient and myself have both had cause to regret it. On the other hand, a great many of the worst types of cases have done well when the operation was properly made through the point of election. The surgeon has complete subsequent control of the antrum, and can keep it open and curette it at any time without inconvenience to himself and with very little pain or annoyance to the patient. The canine fossa, where the bone is very thin, is the next point of preference; the main disadvantages are its distance up under the cheek and the elevation of the opening above the floor of the antrum. The history of the following cases presents some of the difficult problems of this class of cases.

Mr. C. H., aged twenty-five. Presented for treatment, 1891. There was a history of long-continued catarrhal discharge from the nostrils, anteriorly and posteriorly, much greater on the right than on the left, and a most unpleasant odor in the expired breath. The nostrils were very disagreeably stenosed, the right more than the left. The secretions were muco-purulent, excessive in the mornings, at times decidedly creamy in color and consistence, and leaving more or less of a permanent yellowish stain on the handkerchief. The objective symptoms were a moderately deflected septum, hypertrophy and passive dilation of turbinal tissues, which I reduced with electric cautery and chromic acid. On certain mornings there was a stream of muco-purulent matter issuing from the posterior end of the right hiatus semilunaris, and continuing its course, on the upper surface of the inferior turbinal body, to the naso-pharynx, and not, as usual, passing over the inferior turbinal toward the floor of the nostril. After reducing the general hypertrophy, I diagnosed empyema by placing the electric light in the mouth, showing a very dark shadow over the right antrum and bright spot under the left eye; and besides the corroborating evidence of pus discharged from ostium maxillaris, I passed a curved needle through the antrum-wall in the inferior meatus after Mikulicz's method and found pus in considerable quantity. Irrigation of the antrum through the hiatus gave similar results. He had splendid teeth, but on close inspection the right second molar was pale white in color and appeared as though the nerves were dead. This tooth had been filled with an amalgam four years previously and had given no disturbance since. I proposed removal of the tooth and trephining, but he refused an operation in which he would lose a tooth. Subsequently I sent him to a dentist, who removed the filling and found some purulent secretion and offensive gas in the palatine root; he treated it for some time with the hope of arresting the trouble above, but without avail, and the patient finally consented to have the operation performed. Under gas Drs. Bradley and Dixon removed the tooth and I trephined a space about 6 millimeters in diameter through the socket. The antrum was full of the most offensive pus and gas it has ever been my ill-luck to detect. I curetted from the cavity a great deal of granulation-tissue and some carious bone, and after irrigating the cavity with an antiseptic solution, packed it with iodoform-gauze, which remained in for a few days. Subsequently I packed it once a week, and there was very little pus or odor when I removed the gauze. He improved steadily for a few months, wearing a gold tube fitted to a special plate, and irrigated the cavity regularly; then the hole gradually closed, and all of the old-time unfavorable symptoms reappeared. I then removed a part of the external wall of the antrum and found extensive granulations and carious bone, which were carefully curetted. He wore the rubber tube for a long time, and when I saw him last was in a very good condition, the irrigation bringing away daily only a small lump of mucus about as large as a pea.

This is a typical case due to the filling of a tooth before the pathological state in the root had been relieved.

The results in the cases where I have penetrated through the walls of the meatus have not been so satisfactory as those reported by Grant and other European writers. I have noticed that many cases under thorough and careful curetting ultimately did better than those which were extensively or over-curetted, or those in which the curette was used too moderately. I have found the greatest benefit from recuretting, at intervals of about one month, until all bare bone is covered and granulation-tissue cicatrized.

Class VI.—*Atrophic Rhinitis.*—The bacilli of atrophic rhinitis frequently find a permanent home in the sinuses. Robertson of Newcastle-on-the-Tyne and Grünwald have done some original and efficient work in this class of cases. I have found two kinds of cases apparently caused by this affection: one in which the semi-solid putrid débris is confined in the cavity and remains a causal factor in keeping up the condition, and the other in which the tissues have undergone degenerative changes. Irrigations will frequently relieve the first; curetting and drainage are generally necessary to restore the latter.

Class VII.—*Tumors.*—Tumors occasionally develop in these cavities. Early diagnosis is of the greatest importance, for it frequently enables the surgeon to save the patient's life by timely removal, and rescues him from a condition of intense pain and distress. Among the benign tumors mucoceles and osteomata are the most important.

Among the malignant tumors, sarcoma (spindle- and round-celled) and osteosarcoma are the most common. The prompt removal of the superior maxilla in a patient of Dr. Wyeth's and mine has apparently cured him of an otherwise fatal disease.

The patient was sent to me in February, 1894, by Dr. Wyeth for my opinion concerning the right antrum of Highmore. He had been troubled with a diseased tooth, pain in the right upper jaw, and with an extremely unpleasant discharge for two years. A diseased tooth had been extracted. In August, 1892, a local dentist opened the antrum, but the pain continued. In September, 1893, Dr. Wyeth (the patient being under ether) opened and curetted the antrum through the tooth-socket, but little relief from the discharge was experienced. In January, 1894, Dr. Wyeth recuretted the antrum, but the unfavorable symptoms continued.

In passing the curette over the antrum I noticed a thick and peculiar lining on the antrum-walls, which produced very much the same sensation as one experiences when scraping a raw potato. I expressed my opinion that it was a malignant neoplasm, and, upon Dr. Wyeth's suggestion, a specimen was sent to Dr. Prudden, who reported that it was a large-celled sarcoma. In March, 1894, Dr. Wyeth removed the superior maxillary bone, with part of the pterygoid plate. The patient recovered from the operation, and seems to be doing very well with an artificial jaw, and continues in the practice of his profession as a lawyer. There remains one unfortunate result: the continuance of a constant sweetish and extremely disagreeable taste in the mouth. There is a little muco-pus issuing at the point where the section of the naso-lachrymal duct was made. I saw the patient in the summer of 1896, and there was no recurrence.

CLASS VIII.—*Syphilis.*—Gummata frequently develop in the nasal walls of the antrum. I had recently under observation three cases of gumma of the internal wall of the antrum of Highmore. They did well under iodid of potassium and occasional scraping of the necrosed bone.

An illustrative case, Mrs. S., aged fifty, applied to me in 1894. She was suffering from such severe pains in the left side of her head that she had only slept a few minutes at a time for several nights and days. I removed a degenerated gummatous internal wall of the antrum; found the cavity extensively diseased and full of putrid secretion and tissue-débris. Besides local measures I gave her iodid of potassium; controlled the pain for a few days with morphin. She improved rapidly, and in two months was apparently well.

DISEASES OF THE ETHMOIDAL CELLS.

The large number of the ethmoidal cells and the peculiar latency of their affections make it difficult to determine the extent of their pathological conditions and to adopt a successful line of treatment. These cells, in my experience, are oftener diseased than any of the other cavities. Polypoid degeneration is their most frequent affection. The bacteria of grippe and influenza invade these cavities and produce alarming and distressing symptoms. In the young suppurative rhinitis nearly always terminates in atrophic rhinitis, and is a frequent cause of chronic ethmoidal empyema.

Etiology.—Woakes and Thudicum have probably done more than any others to inaugurate active methods of treatment of these cavities. The mucosa of the ethmoid bone seems to have a peculiar proneness to watery infiltration, which if not relieved will terminate in a polypoid state. This condition seems to affect all of the tissues, including the periosteum and the bone, and it ultimately renders the bones soft and brittle. Occasionally the septum, or an exostotic or ecchondrotic growth protruding therefrom, so presses into the ethmoid or middle turbinated body as to close the natural openings, and degeneration takes place as a consequence. In a few cases inflammatory and necrotic processes extend from the antrum to the ethmoid. In others the process extends from the frontal sinus. Cysts occasionally form in one of the cells and extend backward and forward, breaking down the intercellular walls, and finally make their appearance above the inner canthus of the eye, where the bone is probably thinnest.

Again, acute catarrhal inflammation of the Schneiderian membrane is frequently attended by an edema which continues so long that it obstructs the respective openings of the cells for several days. This causes putrefaction of the retained secretions; they in turn irritate or destroy the mucous lining of the cells; and pus either discharges through the normal outlet or forces its way by pressing through it (?) or through an artificial opening. If the pressure has been sufficient to produce necrosis, and if the drainage has not been free, we have as a result chronic thickening with pus-production, or watery edema or polypoid changes. Syphilis at times will form gummatous tumors, which in breaking down present the appearances of polypoid degeneration. Osteomata and malignant tumors in this region are occasionally the cause of considerable pain and a discharge of broken-down tissue-products.

Symptoms.—The most common symptoms of ethmoid disease are muco-purulent discharges through the rhino-pharynx and through the anterior nares, with dull and deep-seated pain around the orbit, frontal region, or in the temporal and occipital regions. In chronic cases the pain is largely dependent upon the retention of the secretions and the amount of periosteal disease. The chronic cases with free drainage usually complain of muco-pus in the pharynx, larynx, and bronchi. Acute cases with stenosis complain of profound oppressive pain and fulness throughout the post-orbital, frontal, and temporal regions, and usually show some mental dulness—the patients complaining of a disinclination to mental activity. In cases of mucocele the symptoms are often very obscure. The pain in the ethmoid region and behind the eye is rather constant and severe; and the nasal walls of the ethmoid rarely bulge or protrude sufficiently to awaken our suspicions, although ultimately the orbital plate, just above the inner canthus of the eye, gives away and protrudes.

Diagnosis.—In cases of acute inflammation and stenosis of the ethmoidal cells the diagnosis is extremely difficult, save when it is inferred from the intense subjective symptoms. The subjective symptoms are usually those of acute and infectious rhinitis; rarely, indeed, do we have sufficient evidence to warrant us in penetrating into one of these cells when a condition of acute empyema exists. Frequently in cases of grippe the patient implores the physician to cut into the cells to relieve the distressing and almost unbearable symptoms of pressure. In chronic cases with discharge the diagnosis is not difficult; but in cases where abnormal conditions obstruct the view there is some difficulty in distinguishing between empyema of the anterior ethmoidal cells, of the frontal sinus, and of the antrum of Highmore. In those cases where the muco-purulent discharge flows from the septal side of the bulla ethmoidalis, the evidence that there is empyema of the anterior ethmoidal cells cannot be disputed. Pus in the superior meatus can mean only one of three things—posterior ethmoidal, or sphenoidal trouble, or subperiosteal bone-disease. Pus issuing from the posterior ethmoidal cells must pass over the posterior end of the middle turbinal body; and when the source is the sphenoidal cell it usually passes behind the tip and over the posterior upper border of the choana. Occasionally sneezing or forced blowing of the nostril forces muco-pus into the upper chambers. In such cases wiping the mucus away and awaiting its reappearance will decide. The posterior rhinoscopic mirror is most valuable in demonstrating muco-purulent secretions in the superior meatus. The degree to which the pathological state has extended can be determined by the objective appearances, especially by the character of the pus, muco-pus, and the edematous, polypoid, and sclerosed states. I have been able to confirm my suspicions on many occasions when the irrigation-tube had been passed into the natural opening. The probe will convey an idea of the diseased state of the membrane, but it is frequently deceptive concerning the bone. The periosteum and mucous membrane of these bones is very thin, and frequently the probe feels as if it was on bare or exposed bone when it is in a fairly normal state. This has led many of our best writers into controversy on the diagnosis of diseases of this region.

Treatment.—Although we have done much in the treatment of ethmoidal disease, many questions in regard to the best methods are yet to be settled. The ethmoid is really the home of nasal polypi; the majority of the serious cases are the cause or consequence of polypi, and are etiological features in the deeper degenerative changes of tissue and bone. All pedunculated polypi should be removed by the wire snare, and I have found the Bosworth snare by far the best for this purpose. In a few cases it is well to pull out the polypi after the wire has been well tightened around the pedicle; on the other hand, it is sometimes better to cut through the pedicle and afterward destroy the small polypi that grow around the base. The profound symptoms of pain, shock, and hemorrhage that follow tearing away great sections of the mucous membrane and bone by traction on the snare should contraindicate its indiscreet use. After the practise of these methods in my cases I have never observed the recurrence of polypi in the space of the pedicle; yet I have noticed little polypi growing around the parts, and that their growth continues, being favored by the absence of the larger ones; these should be removed by some excisor-forceps. I have found Jarvis's to be the best. In nearly all serious ethmoidal cases the question of removing a part or all of the middle turbinal body should be carefully considered, and as it is necessary in most cases, it is well to decide this question early. I do not believe in the method of tearing this bone away with forceps, as advocated by some earlier writers, because the membranous tissues that pass through the cribriform plate with the olfactory nerve, and extend downward over the middle turbinated bone, are quite tough, and sometimes they are torn loose from the bone up to the plate instead of breaking off where the middle turbinated body joins the ethmoidal bone. In my experience I have found the most feasible procedure to be that of making a section with nasal clippers or scissors through the middle of the bone. The Bosworth wire snare with small cannula will remove the anterior and posterior sections readily and effectively, with little disturbance to the membranes of the parts above. Deflected septa, narrow nostrils, and hemorrhage are the chief difficulties to be overcome. The floors of these cells can be penetrated with shoulder-protected drills and trephines with very little danger to the neighboring parts. The antero-posterior nasal

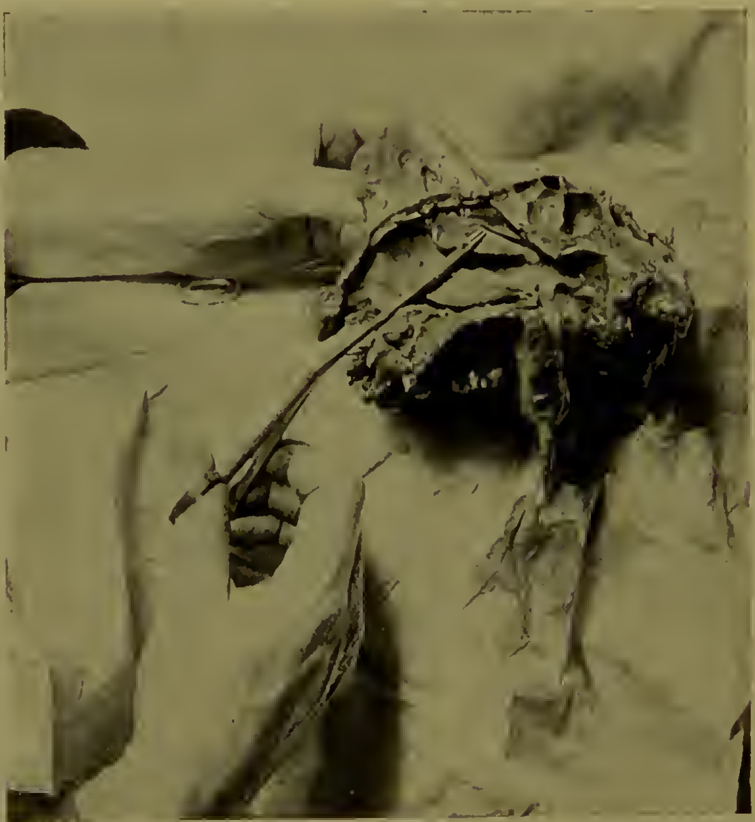

FIG. 591.—Dividing the middle turbinal before sawing off the posterior half to gain free access to the sphenoid sinus.

excisor-forceps, a cut of which I present, has been extremely valuable for enlarging these openings and for removing the floors of the cells. The patient rarely experiences disagreeable results, save in the cases where the cancellated parts of the ethmoid bone have been cut into. The small malleable curettes are extremely valuable in removing pus, polyps, and granulation-tissue. When the holes are large enough the cells usually drain so well that it is necessary to irrigate them at stated intervals only. When the process extends far up into the little cells above the orbital cavity, or in some of the recesses under the cranium, the results of treatment are not so satisfactory. I have found that it is advantageous to freely spray the nose two or three times a day with a preparation of liquid albolene 4 oz., carbolic acid, eucalyptol, and menthol, *āā* 10 grains; this is usually very soothing and beneficial. In the suppurative cases I use the nasal douche, 1 quart of warm water, 1 teaspoonful of salt, $\frac{1}{2}$ drachm of carbolic acid, applied by a fountain-syringe through the narrower nostril; with occasional insufflations of boric acid, aristol, and iodoform. Bosworth reports most remarkable results from drilling into these cavities with an ordinary burr and breaking down the intracellular walls; and I believe that he accomplishes this entirely by the sense of touch and appreciation of distances and directions from the anterior nares.

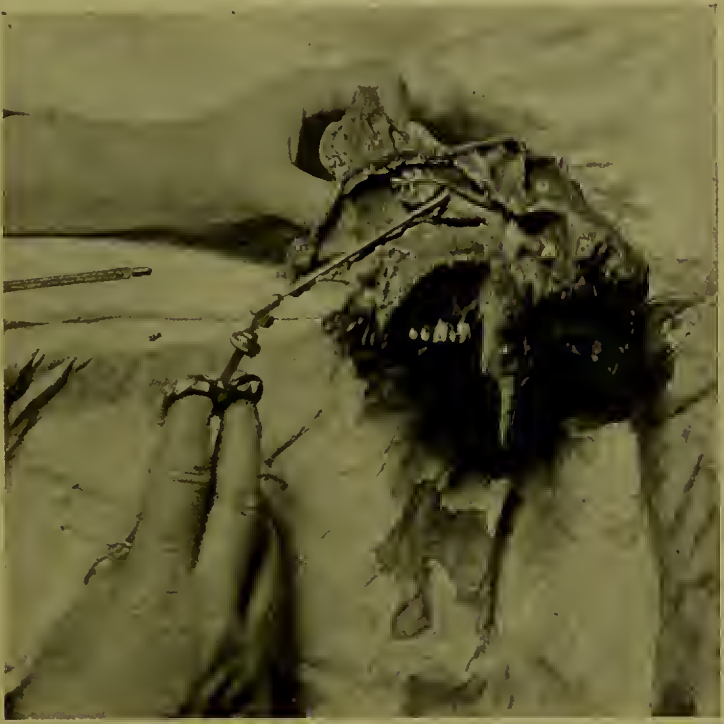

FIG. 592.—Bosworth's snare in position for making the section of the middle turbinal (author's specimen).

As to results, regarded from the standpoint of the subjective symptoms, about three-fourths of my ethmoidal cases are apparently well; but on inspecting them, in the majority of cases, a small quantity of pus and mucopus can be seen either in the nose or issuing from the natural or artificial openings. This increases in winter, and is very much diminished in the summer time.

DISEASES OF THE FRONTAL SINUSES.

The frontal sinuses develop about the age of puberty, and apparently are the extension of the ethmoid cells into the frontal bone. They are much more frequently diseased than is generally suspected, and many supra-orbital headaches are due to trouble in these cavities. Improved methods of inspecting the region of the opening of the infundibulum and the use of silver irrigation-tubes have thrown a great deal of light upon their pathology, and have led to procedures that have indisputably relieved the morbid conditions.

Etiology.—Polypoid or myxomatous degeneration has been the cause of the diseased conditions in the majority of the cases that have come under my observation. Of nine frontal sinuses which I have opened externally, seven had polypi within the cavity and one had fronto-ethmoid necrosis. I have seen a great many cases with polypi in the region of the infundibulum, and evidently extending up into the frontal sinus, which were operated upon per nasi and carefully treated. These cases have improved under drainage, but did not seem to get entirely well. I have had one case of osteoma. I have seen a few cases of syphilitic invasion resulting in necrosis. Parasites sometimes invade this cavity, especially in the southern parts of the American continent, as by the screw-worm or larva of the *compsomyia mascellaria*, cases of which have been so well reported by Sir Morell Mackenzie.

Symptoms.—Pain above the eyes and through the frontal bone is the almost constant subjective symptom of frontal-sinus disease; this is frequently made worse by bending the head forward and downward. In cases of complete stenosis of the infundibulum the pain is very great, and the symptoms of oppression and suffering are profound. In the chronic cases, where the nose is not occluded by deflection or hypertrophy, muco-pus can be seen at the very uppermost end of the lower lip of the hiatus semilunaris, rather anterior to the bulla ethmoidalis.

Diagnosis.—The diagnosis can frequently be inferred from the constant pain, tenderness, and discharge in the region of the middle meatus, but the only infallible test is the demonstration that pus really comes from the cavity. The silver irrigation-tube is by far the most valuable and reliable means of attaining this evidence; although I think that we are justified in operating when the subjective symptoms indicate frontal sinus trouble and when the objective conditions demonstrate that there is pus in the infundibulum and the anterior cells. Tenderness to deep pressure, dulness on percussion, and failure of transillumination (see Plate 14) furnish auxiliary evidence.

Prognosis.—The prognosis, as regards the relief of the pain and the excessive discharge, is very good indeed if we secure and maintain good drainage from the cavity; but in many cases life is jeopardized on account of the opposition on the part of the patient to an external operation.

Treatment.—In acute cases with complete stenosis of the infundibulum the region of the nasal opening of the infundibulum should be thoroughly cocainized and an attempt made to enter the infundibulum with a silver irrigation-tube—a cut of which is shown in Fig. 593. In several cases I have succeeded in dislodging the gas and pus and in equalizing the external and internal atmospheric pressure. It may not be necessary to enter the frontal sinus in all the cases, as the relief seems to be secured

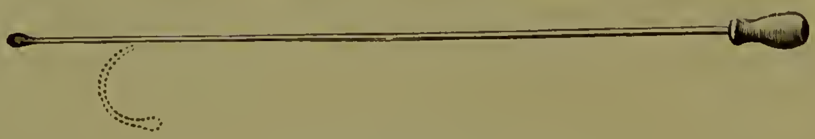

FIG. 593.—Irrigation-tube.

after the manner of that produced by the Eustachian catheter in tympanic troubles. The following case illustrates a brilliant result obtained by this method.

The patient sent for me; I found him almost in a state of collapse and in great agony. He had been suffering for several days with intense pain, together with a full feeling in the right frontal sinus. I sprayed the nostril with cocain and applied it on cotton. The hiatus and infundibulum were very much swollen; the middle turbinal body was moderately so. I passed a tube into the infundibulum and injected gently but firmly a borated solution; a gush of pus and offensive gas followed, with immediate cessation of the severe symptoms. The muco-purulent discharge continued for a few weeks, but the patient recovered completely.

When relief of the retained pus cannot be secured through the nose, and when the subjective symptoms are profound, an external opening should be made without delay by making an incision extending from the center line of the forehead and on a level with and through the eyebrow, or above it, outward to within two millimeters of the supra-orbital notch. A small hole, 6 or 8 millimeters in diameter, should be chiselled through the bone (Fig. 544), the cavity carefully cleansed and inspected, and afterward a probe or bougie should be passed through the obstructed infundibulum into the nose. If deemed expedient, one of the silver retention-tubes can be kept in and the external wound closed. Subsequent irrigation can be easily carried out through the tube in the nose.

The two chief considerations in the treatment of the chronic cases are: First, the removal of the pathological tissues and their products. Second, the securing and maintenance of proper fronto-nasal drainage.

On account of the irregularity in the size of the frontal sinus and infundibulum, the procedure that would be successful in one case would not be so in another with the same pathological conditions. The selection of a place for making the incision and chiselling through the bone is a very important one, and the more I operate the more I am convinced that a small opening should be made just above the supra-orbital ridge, close to the median line; it should then be extended upward and outward for a sufficient distance to make an aperture about 8 to 10 millimeters in diameter. The direction of the chiselling will be determined by the position of the dividing wall of the sinuses. If none of the ridge is removed we have very little resulting depression; and the great advantage is secured of being able to trephine, chisel, and inspect the floor of the sinus, the infundibulum, and the anterior ethmoidal cells, through which, in my opinion, it is absolutely necessary to make a free drainway into the nose. In the other operation which I have performed quite frequently, and which seems best in cases where the wound is intended to be left open and packed for any length of time, it is very difficult to chisel, trephine, and properly enlarge the infundibulum through the hole in this below the supra-orbital ridge-space; although in a few cases I have removed the anterior wall down to the nasal process of the superior maxillary bone and succeeded in making a partially satisfactory and permanent opening into the nose (Fig. 594). Luc has evidently grasped the most practical idea that has yet been presented—that is, to close the external wound at once after having made a large opening through the fronto-nasal canal and inserted a large silver drainage-tube. The after-treatment of these cases consists of irrigating the cavity through the tube for three or four weeks, and then until the discharges cease, continuing the irrigation through the patulous canal which had been created by the tube.

In seven cases with severe and prolonged disease of the frontal sinus I opened nine of the sinuses. One of the sinuses was obliterated by packing for nine months, but there was a resulting depression. The patient is entirely relieved of the original symptoms. In one of the polypoid cases the frontal sinus was opened by the infra-orbital-ridge method, packed and curetted; the necrosed bone was scraped, and this cicatrized over. The patient made a complete recovery, and the sinus has been well since the closure of the external wound. In another case of fronto-ethmoidal abscess the anterior wall of the ethmoidal cells was drilled and chiselled away: almost all of the nasal process of the superior maxillary was removed, the cavity was scraped, irrigated, and drained with a tube, and the sinus seems to have been in good condition ever since. Some of the cases were troubled with acute swelling and retention, and the scar-tissue was reincised with immediate relief. Three of the cases operated upon by the same method remained in apparently good condition up to six months or one year; but in each one of them, on two or three occasions, extreme pain occurred, with swelling in the sinus; the infundibulum seemed to be closed, this being the result of acute cold. Silver tubes were introduced through the infundibuli and the accumulation of degenerating mucus and pus dislodged. The patients improved at once, and subsequent irrigation brought away only clear fluid. At times these patients discharge a mucus from these cavities, which seems to be of a catarrhal and transitory nature.

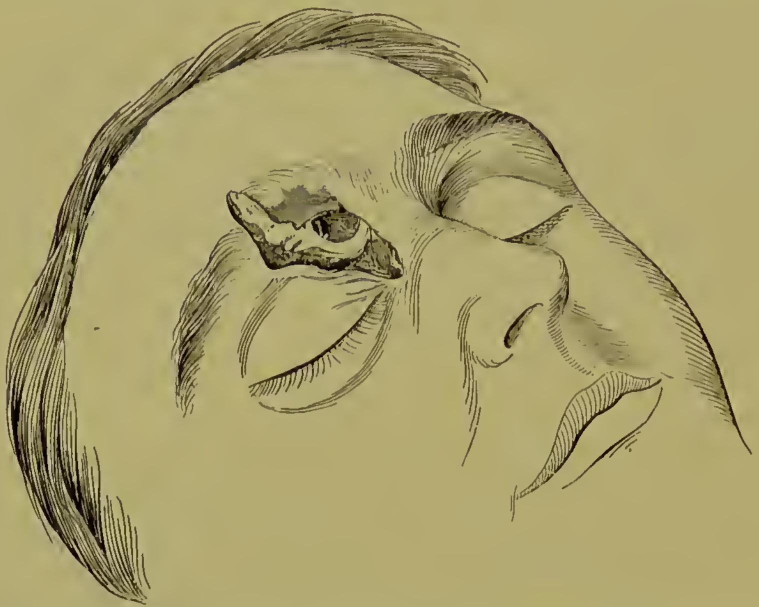

FIG. 594.—Operation beneath the supra-orbital ridge, before upper section has been stitched: intended for external drainage (author's specimen).

DISEASES OF THE SPHENOIDAL CELLS.

Etiology.—Acute inflammations of the sphenoidal cells accompany or are consequent upon acute rhinitis, especially in cases due to infection. Polypi are frequently the cause of chronic disease within the cell. Syphilis commonly affects the cell-wall with a gummatous deposit. Ethmoidal mucocele will occasionally break through the dividing wall. Tumors occasionally develop in or extend into the cavities.

Symptoms.—The subjective symptoms of acute inflammations of the sphenoidal sinuses are headache and a full, heavy feeling over and behind the eyes. In the cases of chronic suppuration, the subjective symptoms are deep-seated pains in the orbital, temporal, and occipital regions, feelings of depression and oppression, discharge of pus or muco-pus over the anterior surface of the sphenoidal cell at the posterior extremity of the middle turbinal body, and disturbances of the field of vision. The objective symptoms are hyperplastic edema of the nasal mucosa covering the cell, discharge of pus, muco-pus, polypi, and pharyngitis sicca, due to destruction of the epithelium by the pus, which flows constantly over the post-pharyngeal wall.

Pathology.—The osseous modification and changes in the vitality of the bone occur in those sphenoidal cases in which the mucosa has undergone polypoid degeneration, the bone becoming brittle and losing much of its cohesive quality. In neglected syphilitic cases, necrosis of the bone or soft tissues always follows the gummatous process. The chronic suppurative cases with stenosis of the normal opening are usually protracted by the irritating qualities of the degenerating products.

Diagnosis.—The diagnosis is comparatively easy in those cases where the nasal fossæ are not seriously obstructed by septum deflections and the throat is tolerant enough to permit posterior rhinoscopy. The obstruction in many cases is the posterior end of the middle turbinal body; its early removal will facilitate matters greatly. Under favorable conditions the pus can be seen flowing from the normal opening, which is situated above the superior turbinal body in the uppermost part of the anterior sphenoidal wall. An irrigation-tube passed through the opening will confirm the provisional diagnosis.

Prognosis.—Since surgeons have adopted the method of making a large opening of 8 to 10 millimeters in diameter into this sinus, the prognosis is much more favorable.

Treatment of Chronic Empyema.—The treatment of chronic empyema is essentially surgical. Much annoyance and delay in the favorable progress of these cases will be avoided by removing the posterior half of the middle turbinal body as a first step in the operation, as it almost always lies in the direct line of the operative field. In my experience the most simple and satisfactory procedure for the removal of the middle turbinal body is carried out by cutting into its middle section with the nasal clippers (Fig. 592), placing the wire of the Bosworth snare in the cut and over the posterior end, and by firm traction removing the whole posterior half. In certain cases a long and rather small silver probe can be passed through the normal opening of the sinus, and this can be followed with some form of gouge or curette. Usually it is best to enter the sinus about $\frac{1}{4}$ to $\frac{1}{2}$ inch

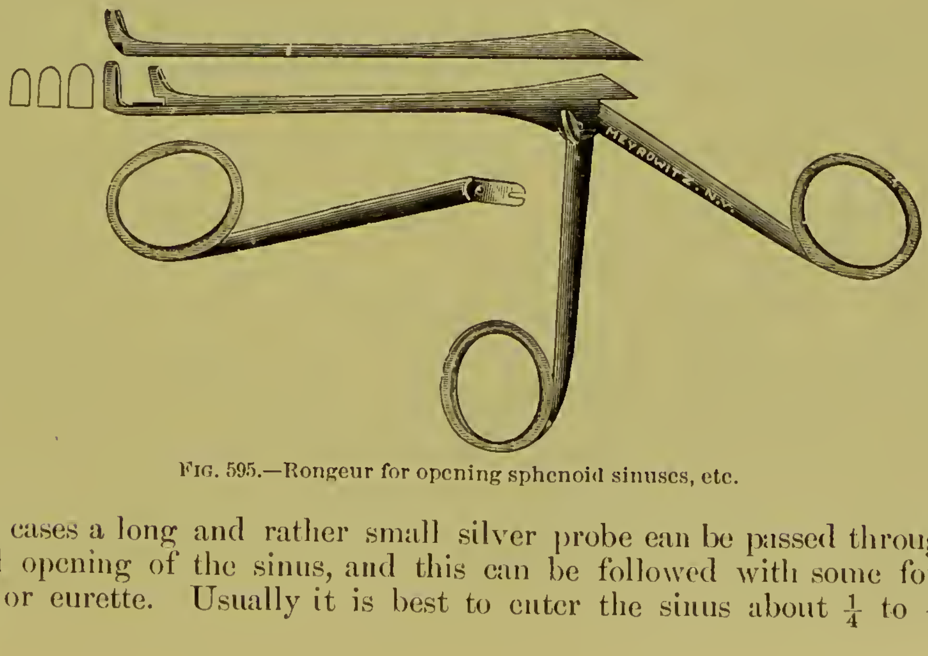

FIG. 595.—Rongeur for opening sphenoid sinuses, etc.

below the normal opening, and about 3 or 4 millimeters externally to the septum. The wall is usually thin at this spot, and the only objection is the probability of wounding the naso-palatine nerve and the spheno-palatine artery, which traverse the bone near this region. After the opening has been made, it is well to pass in one of the smallest size antero-posterior nasal clippers (Fig. 595), and cut out the wall upward and laterally; the instrument cuts after the manner of a rongeur forceps. When the blood is wiped away the sinus can be easily observed and the pathological state rather definitely determined. In my experience polyps have been found in the majority of the cases. It is well to curette them away very gently and carefully, for any tearing of the upper walls might bring on intracranial trouble. I have noticed diseased conditions rapidly improve under simple drainage and careful attention. The tendency of all these openings, even when large enough to admit the little finger, is to close, and it is very remarkable with what rapidity they become occluded. They then require a second excision of the contracting membrane. The syphilitic have given me more trouble than the polypoid cases, because of extension of the necrosis into the body of the sphenoid bone. Tumors occur sometimes in the sphenoid; but they usually originate in the fibrous tissues of the rhino-pharynx or in sarcomatous degenerations of the ethmoid, and extend through the wall into the cell. Certain types of infectious or septic rhinitis invade this cavity and produce a diseased state of the mucosa, which in turn generates a putrid product, and this product acts as a perpetual nidus for new reinfecting material. Proper opening of the sinus and curettage, followed by antiseptic irrigation, usually cures the case or affords decided relief.

Sphenoidal Cases.—In two of my sphenoidal cases the symptoms were so severe that death was anticipated. The anterior walls were punctured, and after breaking through with a gouge the antero-posterior clippers were used to enlarge the opening. The cavities were curetted, and the patients improved at once and steadily. These openings gradually closed, and at the end of six or eight months had to be re-excised; this brought about immediate relief from the severe symptoms which had returned. I noticed in the latter cutting of the bone that it had become much harder than it was originally. One syphilitic case, which is under observation at the present time, is apparently well in a subjective sense, save for a certain amount of post-nasal catarrh; and I can detect dead bone, which extends from the rostrum of the vomer into the sphenoid. I have been gradually removing this necrosed bone at intervals with a drill which excavates laterally.

ACUTE AFFECTIONS OF THE LARYNX AND TRACHEA.

BY WILLIAM E. HOPKINS, M. D.,

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ACUTE CATARRHAL LARYNGITIS.

GUERSANT first clearly described the simple form of this disease. The disease-process consists of a very mild non-dangerous inflammation of the mucous membrane of the larynx, not absolutely confined to any age, but usually occurring in adults, and may run on to a chronic condition.

Etiology.—It may be primary or secondary, idiopathic or the result of some direct and known irritation. Its principal causation is the process known as "catching cold," grafted upon an already slight and possibly chronic hyperemia or congestion of the lining membrane of the larynx. Occurring primarily in the larynx, this disease is extremely rare. Indeed, Bosworth considers it as invariably secondary to an inflammation in some other portion of the upper respiratory tract. The irritation caused by inhaling air not properly warmed and moistened or filled with particles of dust; irritating vapors, such as chlorin, bromin, sulphur, ammonia, tobacco-smoke, etc., predispose to chronic change; and the stimulus of cold produces the acute condition. In early life, frequent attacks of tonsillitis, pharyngitis, and the hypertrophy of the pharyngeal tonsil predispose to attacks of this disease; while in later life some chronic process in the nose or naso-pharynx is frequently found. On account of the greater exposure, it occurs most frequently in men.

Pathology.—The changes in this disease are entirely similar to those occurring in acute catarrhal inflammations of all mucous membranes. There is at first dilatation with engorgement of the blood-vessels and arrest of secretion from the muciparous glands; later there follows a serous and mucous hypersecretion. The greatest swelling is found where the membrane is most lax—at the arytenoid commissure and subglottic region.

Symptoms.—Changes in the voice are chiefly noted. It may be hoarse, dulled, or entirely lost; phonation may be slightly painful and labored; there may be slight dryness, roughness, or tenderness of the throat, accompanied by a tickling sensation. The cough, when present, is dry, harsh, and painful. Except in young children there is rarely any interference with respiration.

Diagnosis.—Changes in the voice and the metallic cough will indicate the seat of disease. The laryngoscope will reveal in mild cases the enlarged blood-vessels scattered over the mucous membrane, and especially noticeable on the cords, commissure, and ventricular bands; in severe cases the membrane may be pink or deep red in color, and there may be small localized hemorrhages. When swelling is noticeable the function of the cords may be interfered with, resulting in aphonia. Infiltration of the muscles interferes with proper adduction. The rise in temperature is very slight, rarely exceeding 100° F.

The disease runs a course lasting from five to ten days and ends in resolution. It is of importance chiefly to singers and public speakers.

Treatment.—The whole upper air-tract should be considered in treating this disease. In the early stages direct local applications should, perhaps, be avoided. The inhalation of steam, medicated with the oil of pine, compound tincture of benzoin or the oil of eucalyptus, with the wet pack locally, should be sufficient. The use of oil-sprays is of unquestioned service. Later in the disease we may try the direct application of astringents, such as nitrate of silver (1 to 2 per cent. solutions), menthol, or some preparation of tannin or iron. To relieve the cough a mild dose of codein may be prescribed. The exhibition of large doses of the muriate of ammonia (30 to 40 grains) will, at times, very rapidly control the disease.

ACUTE CATARRHAL LARYNGITIS IN CHILDREN.

It has been found that in childhood the mucous membrane of the larynx possesses a greater number of vessels and lymphatics than later in life, and that the tissues are less resistant and more relaxed. In consequence, there are some differences, from a clinical point of view, in the disease as occurring in childhood. When the disease develops in early life, certain characteristic features are noticeable in relation to the anatomical region attacked. According as the mucous membrane in the region above or below the vocal cords is the seat of the disease, it naturally follows that we may divide the disease for clinical study into supraglottic and subglottic laryngitis. We may meet either of these conditions up to about fourteen years, although a very large percentage of the cases will be encountered before the fourth year.

Acute Supraglottic Laryngitis.—This runs a course very similar to that of the simple catarrhal laryngitis of adults, and may be considered as identical with it. There is, indeed, somewhat greater tenderness over the upper part of the larynx, and in very rare cases there may be very slight dyspnea. There is the usual morbid predisposing cause to be found in the naso-pharyngeal region, and the common exciting cause of exposure and "taking cold." Its course is short, rarely lasting more than ten days. It is very mild in character and resolves naturally. It may be necessary to differentiate it from a slight croupous laryngitis. This may be done by observing the suddenness of the onset of the latter disease and its steadily progressive course.

Subglottic Laryngitis; False Croup; Millar's Asthma; Laryngitis Stridulosa.—The entire surface of the larynx is more or less involved in this form of inflammation, but the intensity of the process is much greater in the tissues below the vocal cords. The mucous and submucous connective tissue becomes infiltrated and swollen, leading to more or less dyspnea.

Etiology.—There seems to be a constitutional tendency to this disease. Heredity seems to be associated with it. Several children in the same family or families closely related will suffer from repeated attacks. Strumous children are predisposed to it, and those with an abnormally large and active lymphatic system. Gerhardt insists that the chief predisposing cause will be found above, in enlarged tonsils or other obstructions in the air-passages. While this may undoubtedly influence any disease of the larynx, no close causative connection can be found associated with this particular form of laryngitis. The exciting cause is practically the same as in the previous class.

According to Sappey (*Anatomie Descriptive*, 1868, vol. ii. p. 869), the very abundant lymphatic supply found in this region in children explains the marked and at times extreme swelling found in the acute stage of the disease. The pathological condition is more or less stenosis from the crowding forward of the congested and inflamed mucous membrane by the engorged lymphatics.

Symptoms.—There will be some prodromal symptoms sufficiently severe to indicate marked systemic disturbance—the general feeling of malaise, severe or slight headache, the accelerated action of the heart, and the temperature increased to 100° or 101° F. The voice, at first hoarse, rapidly becomes shrill and metallic, and phonation may be very painful. A croupy cough sets in early, and is of a harsh, dry, barking nature. Even after phonation is entirely suspended this cough retains its characteristic sound, proving quite conclusively that it is produced by the dry, swollen tissues below the cords. This process is similar to inflammations of other mucous membranes, and after a period of variable length, usually two or three days, the mucous secretion is resumed, the cough becomes softer and less irritating, and there is some little frothy expectoration. During the day the symptoms are invariably less severe, while at night exacerbations occur that have a seemingly alarming import. The child, somewhat relieved by the restful day, falls into a calm and easy sleep. This may continue several hours, when he suddenly awakens in a violent and agonizing struggle for breath. The face is flushed, the lips purple, the nails blue, and every muscle tense and contracted—all of the characteristic symptoms of marked dyspnea. These serious symptoms may continue for half an hour or longer; finally the child succeeds in coughing up a quantity of inspissated mucus and the attack subsides. A period of relief and rest will follow for a few hours, when the child again wakens in a similar paroxysm. These exacerbations occur only at night and separated by periods of complete remission of dyspnea. Usually there will be from four to eight of these violent seizures during the progress of the disease. The question of muscular spasm is a mooted point. That true spasm of the laryngeal muscles is a prominent factor in these seizures is asserted by Rilliet and Barthez,[1] D'Espine and Picot,[2] J. Lewis Smith,[3] and Gottstein;[4] while Bosworth,[5] Rauchfuss,[6] and Dehio claim that muscular spasm plays no important part, and if it occur is purely incidental. Probably the principal cause is the swelling, which is greatly increased by the presence of the dried mucus acting as an irritant foreign body; it is also probable that the same irritation produces a certain amount of spasm of the laryngeal muscles.

There is a persistence of more or less difficulty of breathing throughout the attack, but only at night do the paroxysms become sufficiently severe to occasion distress. During the remissions a slight inspiratory murmur, higher in pitch, will be heard. On succeeding nights the paroxysm will recur at about the same hour as the first, although, as a rule, with diminished severity.

Diagnosis.—Though difficult and often impossible, an effort should be made to examine the parts with the laryngoscopic mirror. When a view is secured the mucous membrane appears inflamed and engorged, while protruding between the vocal cords will be seen the rounded swollen masses of the subglottic tissues. These are of a deeper red than the cords and the tissues above. Differentiation must be made between this condition and membranous croup, diphtheria, foreign bodies, and perichondritis. In both membranous croup and diphtheria there is much greater systemic disturbance; the temperature ranges higher, the cough is less marked and not so severe, the disease is progressive, and is not characterized by nocturnal exacerbations with almost complete remissions; also the false membrane can generally be seen *in situ* or attached to surrounding tissues. A foreign body may give rise to many of the symptoms of acute subglottic laryngitis; but the history, together with an examination by means of either the mirror or the index finger, will generally clear up the diagnosis. Perichondritis of the cricoid cartilage is more difficult to exclude; but with the aid of the laryngoscope the irregular nodulated swellings, generally unilateral, can be seen and easily recognized.

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[1] *Maladies des Enfants*, 1853, p. 351.

[2] *Maladies de l'Enfance*, 1884, p. 612,

[3] *Diseases of Children*, Phila., 1890, p. 646.

[4] *Die Krank. des Kehlkopfes*, 1892, p. 80.

[5] *Nose and Throat*, p. 504.

[6] *Handbuch der Kinder-Krankheiten*, 1878, p. 116.

The disease runs a course of from six to twelve days, and, as a rule, is not dangerous, a fatal termination being very rare.

Treatment.—The general health of the patient should be considered. The strumous, lymphatic child, subject to attacks of croup, should be toned up with syrup of the iodid of iron and cod-liver oil. The passages above should be looked after with care and relieved if found in an unhealthy condition. During an attack the child should be confined in a warm and moisture-saturated atmosphere; the bowels should be acted on by repeated small doses of calomel; while internally the ammonias and small doses of an opiate should be administered to stimulate the secretion of mucus and to allay the irritating and exhausting cough. During the acute paroxysms at night every effort should be made to soften and expel the dried mucus and to moisten and soothe the dry, irritable, and inflamed mucous membrane. With this end in view we may use a hot bath, steam-inhalations, or hot fomentations, and these failing, excite free emesis by tickling the fauces with the finger or a brush, or by administering an emetic, such as ipecac. If the attack is extremely severe or there is dangerous dyspnea, inhalations of ether or amyl nitrite may be given, the O'Dwyer tube introduced, or the trachea may be opened.

ACUTE PHLEGMONOUS OR EDEMATOUS LARYNGITIS.

Much confusion in classification is encountered in the literature of this disease. Cohen[1] describes edema and acute, chronic, infraglottic, and hemorrhagic edematous laryngitis; while the different forms of the disease are divided by Mackenzie[2] into typical, contiguous, and consecutive edematous laryngitis. Ziemssen[3] recognizes only one form, laryngitis phlegmonosa; while Gottstein[4] and Schrötter[5] describe acute and chronic submucous laryngitis and acute and chronic edematous laryngitis. Browne[6] acknowledges only acute and chronic inflammation of the submucous tissues.

The presence or absence of high temperature and other acute inflammatory symptoms renders this disease clearly divisible into two general forms—acute phlegmonous laryngitis and simple edematous laryngitis. The occurrence of either form is rare, the latter especially so.

Acute Phlegmonous Laryngitis.—This is an acute inflammation of the laryngeal mucous membrane, to which is added edema due to serous effusion. The edema here follows the characteristic course of inflammatory edema in other tissues and exhibits the different stages of serous, seropurulent, and purulent edema.

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[1] *Diseases of the Throat and Nasal Passages*, 2d. Ed., 1879.

[2] *Diseases of the Throat and Nose*, American Ed., vol. i. p. 277.

[3] *Cyclopedia of Medicine*, American Ed., vol. vii. p. 791.

[4] *Die Krankheiten des Kehlkopfes*, 1888. [5] *Vorlesungen über den Krank. de Kehlk.*, 1887.

[6] *The Throat and Nose and their Diseases*, 3d. Ed., 1890.

Etiology.—In addition to cold, the usually assigned cause, there is undoubtedly exposure to some septic infection. Such an authority as Mackenzie states that he never encountered a case except of septic origin. Virchow considers it a true erysipelas of the larynx. It is indeed usually found among hospital physicians and nurses, undoubtedly the most exposed class of people. It is very rare as a primary condition, being found generally secondary to quinsy, abscess of the neck, follicular pharyngitis, and tonsillitis, or complicating an attack of typhoid, typhus, variola, or diphtheria. It may develop at any age, but is usually found between twenty and forty.

The same morbid changes are found as in inflammatory edema of mucous membranes elsewhere. There is first vascular engorgement followed by serous effusion, the swelling being most marked where the membrane is most relaxed—that is, in the aryepiglottic folds, ventricular bands, and the epiglottis posteriorly. At first serous, the effusion gradually becomes purulent.

Symptoms.—A slight chill accompanied by a corresponding rise of temperature is rapidly followed by decided impairment or loss of voice, with dyspnea and stridulous breathing. The condition is progressive, the dyspnea developing within twelve hours, growing steadily worse for twenty-four to thirty-six hours, when it reaches its maximum. There is pain and soreness on pressure or swallowing, and cough is not often present.

Diagnosis.—This disease can only be confounded with the presence of a foreign body or an attack of simple edema. The history of the case and the use of the mirror should prevent mistakes. You will see the red, tense, and glossy membrane with three rounded swollen masses of tissue above the small triangular opening of the glottis.

Prognosis.—This is a disease of rapid development. It runs a short course of four or five days, the extent and severity of the symptoms varying largely. If at the end of thirty-six hours the dyspnea has not become dangerous, the case will spontaneously resolve. Until this time, however, it should be closely watched, as symptoms sufficiently alarming to demand surgical interference may occur at any moment.

Treatment is at first the use of the ice-bag or Leiter coil to the larnyx, with local depletion (leeches) externally, and free and frequent scarification of the swollen, inflamed mucous membrane within. The atmosphere should be warm and saturated with moisture, and only such drugs as will stimulate secretion should be administered. When serious symptoms develop so suddenly as to prevent tracheotomy, the introduction of a small laryngeal catheter is advised by Macewen.

EDEMA OF THE LARYNX.

Under this name is considered that morbid condition which presents a simple edema of the mucous membrane of the larynx, without inflammation, and which is certainly secondary to a more serious general condition.

Etiology.—Some morbid change in the kidneys, heart, or liver, an obstruction to the return circulation in the neck, a vaso-motor paresis, or any general or local condition which tends to produce dropsical effusion may be the cause of this disease. There is an escape of normal healthy serum into the submucous tissues, producing general swelling of the parts and noticeable tumefaction in the relaxed portions of the mucous membrane, the aryepiglottic folds on each side, and the epiglottis in front and above.

Symptoms.—The onset is sudden. There will be loss of voice, with great difficulty in breathing, inspiration being more difficult than expiration. There is little pain, soreness, or cough.

The **diagnosis** is easily made by the history of the case and laryngoscopic examination.

The **prognosis** is always grave. Death from the laryngeal stenosis is liable to occur and very quickly; but even should this be controlled, the general condition is almost invariably of an organic nature and incurable.

Treatment.—Efforts should be made to control, at least temporarily, the systemic cause. Free diaphoresis or catharsis is indicated, while local puncturing of the swollen tissues freely should be frequently done. This not availing, resort should be had to tracheotomy.

CROUPOUS LARYNGITIS.

Synonyms.—Croup; Membranous laryngitis.

It would hardly prove profitable to enter into the active discussion that has been carried on for many years past regarding the unity or duality of croup and diphtheria. Perhaps the weight of modern evidence tends to the belief that croupous laryngitis is a local affection with some general disturbance; while diphtheria is a general systemic disease with local expression. It is not yet demonstrated, but largely a matter of opinion gained from personal observation and experience. The literature on the subject is most confusing. Statistics in general are not to be depended on, and even mortality statistics are unreliable owing to frequently varying opinion. While there are many points of similarity, there are also enough elements of distinction to warrant the consideration of croupous laryngitis as a disease distinct from diphtheria.

Etiology.—That there is at least some similar or analogous causative element in this disease to diphtheria cannot be denied. In diphtheria proper its distinctive germ can generally be detected; while although the germ of non-diphtheritic croup has not yet been separated, the possibility and probability of its future discovery had not been abandoned. It is likely that a germ finds lodgement in the pharynx, tonsils, or larynx, which excites an inflammatory process with certain well-marked and peculiar characteristics. The disease may commence above in the pharynx or fauces, progress downward, and attack the laryngeal mucous membrane secondarily. It is selective, and age and susceptibility play important parts. True croupous laryngitis is practically unknown in adult life, while it is most common between the ages of one and nine years, rapidly diminishing in frequency from this time on.

Pathology.—The membrane consists essentially of two layers—a superficial, consisting of the epithelium that has proliferated and undergone mucoid degeneration, and a deeper, composed of fibrinous strata, with numerous leukocytes scattered throughout its layers.

Symptoms.—At first there is generally slight catarrh, with some rise of temperature and a general feeling of languor; there may or may not have been a chill. Loss of appetite and persistent thirst accompany painful deglutition. The pulse is full and the skin hot and dry. After a few hours there is slight hoarseness, and later a short, dry, shrill cough; the voice becomes more impaired and assumes a whispering character. Then interference with respiration appears and there is some laryngeal stridor. The mucous membrane is bright red, and may show some patches of false membrane. These symptoms usually occupy the first twenty-four to forty-eight hours of the disease and are followed by attacks of dyspnea. The voice is lost, the face is red and anxious, there is a hoarse, stifled cough, with little or no expectoration. The attacks at first last but a few moments and subside, although the stridor remains. The pulse increases in rapidity and is irregular. The attacks of dyspnea become more and more frequent until they are practically constant, with no remissions and occasional aggravation of the symptoms. From time to time pieces of the membrane are coughed up. The struggle for breath becomes each moment more painful and exhausting, and finally death supervenes from suffocation.

Diagnosis.—True croup must be differentiated from acute catarrhal laryngitis of severe form and from diphtheria. In the former there is absence of the membrane, frequent cough, the attacks come on only at night, and there are absolute and prolonged periods of rest with complete absence of dyspnea.

For the differentiation from diphtheria, see the article on that disease.

Prognosis.—This is a most serious disease; death may occur at any time from dyspnea.

Treatment.—This should be both local and constitutional. Internally the preparations of mercury should be administered. They can be given in frequent and increased doses. The salts of iron, notably the tincture, are most valuable. Locally ice may be used in the form of the pack, and small lumps may be swallowed. Sprays of lactic acid and persulphate of iron are also valuable. The chief danger to be guarded against is suffocation; so everything should be in readiness for the performance of intubation or tracheotomy, and interference when demanded should not be delayed. An expert in both operations will generally select the former procedure as being simpler, more rapid and less dangerous in itself, knowing that should intubation fail, the trachea can then be opened.

DIPHTHERIA.[1]

This is an acute infectious disease having local manifestations in the upper air-passages.

It has been known and studied from the earliest times, but no absolute evidence as to its causation was produced until 1868, when Oertel made the announcement of the presence of a micrococcus in the exudate that is characteristic of this disease alone. This view was confirmed by many other investigators, notably Recklinghausen, Prudden, and Wood and Formad, who carried on many elaborate culture-experiments; but until the announcement by Klebs and Löffler of the definite microscopic characters of the bacillus which is peculiar to this morbid process, the discussion was not set at rest.

Etiology.—A diphtheritic attack is undoubtedly precipitated by a deposit of the Klebs-Löffler bacillus upon the faucial or laryngeal mucosa. There, finding a favorable culture-medium, it sets up its peculiar inflammatory process; and as the result of the life-functions of the bacilli there is generated a ptomain that, absorbed by the capillaries, enters the general circulation and produces the constitutional symptoms. This theory, first advanced by Cheyne, was subsequently confirmed by Brieger and Fränkel, who injected in rabbits the filtrate of the diphtheritic membrane, entirely separated from the bacilli, and reproduced the general disease, but without the local laryngeal manifestations.

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[1] See page 1010. The different standpoints of the two writers seem to justify duplication.

A very large majority of cases occur in childhood, and at least seventy-five per cent. prior to the age of ten years. Cold and damp climates and the periods of the year when these conditions prevail undoubtedly predispose to the disease. All catarrhal processes, enlarged tonsils, the presence of adenoid growths or diseased nasal fossæ render one more liable to the infection. Absence of sanitary surroundings is an important element, the disease having undoubtedly a filth-origin and the bacillus thriving best in the neighborhood of sewers, street-cuttings, turned earth, and locations shut off from sunlight. Diphtheria is both contagious and infectious; it may attack individuals, it may develop only in a limited community from some special local origin, or it may be epidemic and spread over a very wide area; but wherever and whenever it makes its appearance, it is without doubt due to the presence of its own specific organism.

It may be carried in clothes, in letters, or in the furnishings of railway-carriages; while drinking-water and milk are favorable transportation-mediums. It is a disease common to the lower animals, and a pet animal will often convey it to its owner. There is no question as to the vitality of this germ, but its activity must be somewhat restricted. It will be found redeveloping in hospital-wards years after their abandonment and thorough disinfection; but the area of its activity must be limited when you realize that all cities and large towns are the best breeding-places for the bacillus, and yet the number of cases occurring each year represents but about one to every thousand of population. The danger of breath-transmission is small, the secretions retaining the bacilli; yet small particles may be thrown out by coughing or sneezing, and these deposited on some mucous surface will serve to propagate the disease.

Pathology.—The bacillus, finding lodgement on the mucous membrane, reproduces itself with great rapidity. It forces its way into and through the epithelial layers into the mucosa, causing inflammation of that membrane. There is dilatation of the blood-vessels, exudation of serum, and escape of the leukocytes. The epithelial cells proliferate, and uniting with the fibrin, which coagulates on exposure to the air, form the false membrane. Thus will be seen a pathological process identical with croupous inflammation, except for the presence of a specific organism (Bosworth). The inflammatory process is so energetic, the fibrinous bands contract so rapidly, that necrosis of the false membrane, as well as of the superficial layers of the true mucosa, will take place, and sloughs will form and be thrown off, leaving the raw and bleeding surface exposed. The membrane quickly re-forms on these spaces or resolution takes place. In mild cases the false membrane is very thin and superficial and penetrates to very little depth; while in malignant cases the entire mucous membrane may be infiltrated. As a rule, the exudate first appears on the tonsils or faucial arch. It may extend into the nasal spaces but, as a rule, it passes downward, involving the pharynx, larynx, trachea, and even extending into the bronchi. When in the lower air-passages, the false membrane assumes more the croupous form, penetrating but slightly into the mucous tissue. Some of the organs show slight changes: the kidneys and liver may be somewhat enlarged and minute hemorrhages may be found; while in the brain and spinal cord minute extravasations of blood are found scattered throughout their tissue.

Symptoms.—In direct contagion the period of incubation is very short, not more than thirty-six hours; where the infection is conveyed, it may be much longer, varying from three to ten days. Experimental inoculation may develop the disease in twelve hours. In a typical attack of the disease you will have the false membrane not only involving the tonsils and fauces, but penetrating the larynx, and in addition the serious constitutional disturbance caused by the toxic absorption. There may be the general prodromal symptoms of malaise, restlessness, and loss of appetite. Sometimes there is vomiting and great nervous excitement, even convulsions. The direct onset of the disease is marked by a chill or chilly sensation, followed by mild febrile disturbance, dry, flushed skin, headache, and scanty, highly colored urine. The mental processes are unusually dulled, and the patient often lies in a half-stupid condition. The febrile reaction is not severe, the temperature rarely rising above 102° F. The heart's action is weak and rapid. Accompanying these symptoms there will be dryness of the throat, some pain and difficulty in swallowing, and soreness and tenderness in the tissues of the neck. At the end of twelve hours, if the throat is examined, thin circumscribed patches of whitish or pearl-colored membrane will be seen on the tonsils or fauces; and at the end of twenty-four hours these patches will have completely covered the tonsils and assumed the characteristic yellowish and velvety appearance. The mucous membrane is intensely injected and somewhat discolored. Within three days a purulent or muco-purulent discharge sets in, the membrane continues to spread, the edges become ragged, and sloughing begins. If the membrane progresses upward, the soft palate swells, the uvula becomes edematous, and the nasal passages become occluded by a mass of membrane and muco-purulent secretions; the tongue becomes dry and brown; the breath fetid from the necrotic membrane and decomposition of the secretions. About this time the serious symptoms of laryngeal involvement will appear. There will be another rise in temperature, the voice changes, and the development of dyspnea, as shown by increased inspiratory effort, the subclavicular depression, and the fixation of the chest-muscles. The laryngeal obstruction is due to the narrowing of the passage by the exudation, and perhaps in part by muscular paresis. In the larynx the membrane is more characteristic of the croupous deposit, except in spots (Prudden) where it invades the mucous tissue. If life be prolonged for two or three days the membrane may become separated, and at times a membranous cast of the trachea will be thrown off. Resolution may take place as in the upper part of the pharynx, or similarly there may be a fresh exudate. This may be considered as a description of a case of moderate severity. In the simpler forms there may be very slight systemic disturbances; and the false membrane, if any, thin, almost transparent, and consisting of a few scattered patches. In the malignant form the attack will be characterized by profound symptoms of toxic absorption. The usual features of blood-poisoning will be noticed; and indeed, in a case of this class, the vital powers will apparently be overcome almost from the onset by the virulence of the poison. Convulsions or low, muttering delirium may be constant; there will be absence of tendon-reflex; rapid, feeble, and irregular pulse, or a condition of semi-coma.

Diagnosis.—It is chiefly necessary to make the distinction between this disease and membranous croup. In the early stages this may be attended with some difficulty. The croupous membrane is thin, of a whitish color, with a glazed, shining surface, and can be easily wiped away without irritating the surface beneath; the diphtheritic membrane is thicker, has a soft, velvety appearance, a yellowish-brown color, and is so adherent to the mucous tissue that its removal is not easy, and will leave a raw and bleeding surface beneath. Later in the diphtheritic process there will be fetor, a profuse muco-purulent discharge, and the dirty bluish-black, ragged, necrotic membrane. The croupous membrane undergoes no change until the end; it continues clean and white, and has no mucous or purulent discharge. In recent times the true scientific method for determining the presence of the diphtheritic process has been followed. Knowing with what rapidity the Klebs-Löffler bacillus multiplies, a small portion of the exudate is transferred from the throat to a properly prepared culture-tube partly filled with peptone, bouillon, or blood-serum. In twenty-four hours colonies of the bacilli will form that can be recognized by the naked eye, and the bacilli can be demonstrated under the microscope. This plan, so simple, safe and certain, is being rapidly adopted by the entire profession; and most of the large cities employ a competent bacteriologist, a large part of whose duty it is to make these investigations.

Prognosis.—Diphtheria is rightly regarded as one of the most fatal of diseases. The mortality-rate is large, and there are many complications and sequelæ. Until very recently the mortality-rate varied from 40 to 60 per cent. Under the influence of the treatment by antitoxin this has fallen to from 12 to 20 per cent. Two causes are active in producing a fatal termination, the asphyxia secondary to laryngeal stenosis and the overwhelming of the nerve-centers and organs by the blood-poison. The toxic effects may be marked in the mildest form of the disease as well as in the most virulent. There may be much interference with the cardiac function, due to the action of the poison on the nervous centers controlling it, or there may be instant cessation of the heart's action, due to the overwhelming effect of the poison upon the heart-muscle itself. Among the most important complications and sequelæ may be noted albuminuria, bronchitis, changes in the abdominal viscera, purulent inflammation of the middle ear, and paralysis of the various muscles.

Treatment.—The two points to be kept in mind in the treatment of diphtheria are to prevent the spread of the local process and to control the systemic effects of the ptomain-poison. In consequence, there should be systematic local and constitutional treatment. Innumerable preparations have been used locally, and among them may be mentioned solutions of bichlorid of mercury, even as strong as 1 part to 500 (Sternberg), carbolic acid from 5 to 30 per cent. (Ranlin), lactic acid from 30 to 50 per cent. (Bosworth), the persulphate or perchlorid of iron (Bosworth), the nitrate of silver 5 to 10 per cent. (Trousseau), hydrochloric acid, nitrate of mercury, chlorid of zinc, bromin (15 per cent.), solution of pancreatin, trypsin, and other digestive ferments, the officinal aq. calcis, the peroxid of hydrogen by spray and inhalation—all of these applications have their advantages, and each its special and ardent advocates. The application should be made only under good illumination and with the greatest care. The object of various local applications is to destroy the pathogenic organism by direct action; in consequence, they should be applied directly to and around the margins of the membranous deposits. Internal medication is indicated to combat the effects of the poison by sustaining the resisting powers of the system. The preparations of alcohol are undoubtedly best for this purpose, and whiskey and brandy should be freely and frequently administered. The tincture of iron in large doses is most important, while such drugs as digitalis, strophanthus, carbonate of ammonia, and musk, especially support the heart's action. The mercurial treatment is strongly advocated by eminent and experienced observers, the mild chlorid, the corrosive chlorid, and the cyanid each having its supporters. Various antiseptic sprays have been found extremely useful, and will come in contact with diseased tissues beyond the reach of direct applications. The constant use of steam, both in the atmosphere and by inhalation, prevents the dissemination of the germs, keeps the surface of the tissues moist, and enables the gangrenous membrane to separate more readily. The recent introduction of antitoxin in the treatment of diphtheria marks an important advance. It is too early as yet to decide upon the ultimate value of this method. It is claimed, however, that the mortality has been so greatly reduced by its use as to remove the fear heretofore felt for this dread disease.

After every effort has been made, every method tried, a very large proportion of cases will still show that the laryngeal stenosis is progressing, and without surgical interference there is imminent danger of suffocation. We may then choose between opening the air-passages or introducing an intralaryngeal tube. The individual experience of the operator will decide which method to follow: either may be relied upon to give temporary relief; but the progressive advancement of the disease will overcome, at times, every effort made (see page 1029).

LARYNGISMUS STRIDULUS.

Synonym.—Spasm of the glottis.

This condition is more a symptom than a disease. It is a spasmodic closing of the glottis, purely neurotic in its character.

Etiology.—It may occur at any age, but is most frequently found in children, especially if they are ill-nourished or rachitic. The spasm is usually brought on by something that nervously unbalances the child—loud talking, coughing, teasing, irritating, or perhaps a drop of water or milk finding its way into the larynx during feeding.

Symptoms.—There are two or three labored efforts at inspiration, followed by total cessation of breathing. This may pass in a moment and respiration be resumed. The spasm may continue, the glottis never relax, and death at once supervene. There may be but one attack, or there may be several before the fatal issue; and there may be general systemic convulsions. There is no recognized pathological change whatever. The disease is instantly understood even by the inexperienced.

Treatment.—Sudden shock, slapping the sides and back, dashing cold water on the naked body and face, the application of strong ammonia or amyl nitrite to the nose, or forcing a catheter or intubation-tube past the obstruction in the larynx.

ACUTE PERICHONDRITIS.

Acute inflammations of the perichondrium of the laryngeal cartilages are occasionally met with.

Etiology.—The cause may be idiopathic, or the disease may follow typhoid, typhus, diphtheria, pneumonia, or any of the exanthemata. Syphilis is a very prevalent cause. The pathology is the same as that of a perichondritis in any location. Increased vascularity, followed by swelling, effusion, and pus-formation, separating the perichondrium from the cartilage.

Symptoms.—There is usually some systemic disturbance, a feeling of malaise, chill, etc., followed by a slight rise of temperature, with a sense of fulness in the larynx, soreness, pain on swallowing, slight dyspnea, and more or less loss of phonation. The local symptoms depend largely upon the extent of inflammation and the particular cartilages involved.

When the cricoid cartilage is the seat of the trouble dyspnea and loss of phonation are the principal symptoms. There may be cough. In affection of the arytenoid there is some slight dyspnea and impairment of voice; but interference with deglutition is the principal symptom.

When the thyroid is involved it is usually unilateral, and interference with phonation is the principal symptom. The voice is never entirely lost, but becomes very hoarse. There may be a purulent discharge through a fistula in the neck.

Diagnosis.—This is often made with very great difficulty. Careful and thoughtful consideration, with frequent examinations with the laryngoscope, will enable one to detect the diseased cartilage or exclude the diseases simulating it. These are croupous laryngitis and acute catarrhal laryngitis.

Prognosis.—There may result necrosis of the cartilage, with fistulous passages to the surface. There is final resolution usually, with some permanent voice-changes. There is little real danger to life.

Treatment should be the administration of mercury and iodid of potassium, and surgical measures may be called for from time to time to curette or scarify the tissues internally or to open pus-sacs or fistulous passages.

HEMORRHAGIC LARYNGITIS.

Hemorrhages into the larynx, or the so-called hemorrhagic laryngitis, is an extremely rare condition, unless secondary to ulcerative processes such as are found in syphilitic or cancerous diseases. Türck cites a case as occurring from syphilitic ulceration and Mackenzie describes it as one of the symptoms of acute laryngitis. The only point of practical importance is to determine whether the bleeding is from the larynx or the bronchial tubes; as in the former case it is of little consequence, while in the latter it is an indication of probable tubercular changes.

ACUTE CATARRHAL TRACHEITIS.

The development of an acute inflammatory process localized solely in the trachea is indeed of very rare occurrence. That this structure takes part in every severe inflammation that involves the larynx and fauces above and the bronchial tubes below may be expected, both from its direct connection and similarity of structure. That acute catarrhal tracheitis does occur, however, alone and idiopathically, is undoubtedly true; and it runs a course parallel to and of the same character and intensity as diseases of like nature in the tissues above and below. It is almost invariably of a catarrhal form, and is followed very rapidly by an extension of the disease to the larynx and bronchi.

Etiology.—The causation when it develops independently is the same as in the neighboring structures. There is the usual predisposition dependent upon chronic changes in the mucous tissues above, and exposure serves to light up the process. It is in reality almost always an extension downward of a laryngeal catarrh that has itself extended from above. In youth it is generally consequent upon an acute rhinitis; while in later life it is secondary to a bronchial catarrh. It may occur at any age; and, like other inflammations of the air-tract, it is found most frequently in the male, dependent, no doubt, upon their greater exposure to the exciting causes—*i. e.*, sudden climatic changes, wet clothing, draughts, and dust.

Pathology.—In the early stage there is the usual vascular injection and turgescence and some slight swelling from serous exudation. The surface will be dry and glazed. Later, when mucus secretion is resumed, the swelling subsides and resolution follows.

Symptoms.—A dry, irritating cough, caused by the air-current passing over an inflamed surface, and a constant tickling sensation causing a continuous effort at clearing the throat, but totally devoid of expectoration. Ordinarily there is no dyspnea, as the trachea will allow of great encroachment on the caliber of its lumen without interfering with the normal air-current; but in very severe cases there may be slight dyspnea. As the disease runs its course the irritating cough gradually subsides and expectoration increases. This is greater in quantity than in catarrhal laryngitis and much less than in bronchitis. If the stethoscope is applied to the trachea there will be heard in the early stage a harsh, dry, inspiratory sound, and later on an abundance of large moist râles.

Diagnosis.—An acute respiratory disease with cough and expectoration, but without dyspnea or aphonia, must involve either the trachea or bronchi. The stethoscope will exclude the latter region, and if a tracheoscopic examination is made the mirror will quickly show the highly injected, dark-red, inflamed mucous membrane.

Treatment.—The local application of the wet compress or counter-irritation with a tampon. The inhalation of vapors saturated with benzoin, eucalyptus, or some of the essential oils. A mild expectorant-mixture containing ammonia may be given.

CHRONIC INFLAMMATORY DISEASES OF THE LARYNX.

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CHRONIC LARYNGITIS.

As here understood, the term chronic laryngitis simply means a condition of the larynx brought about by chronic inflammation affecting either the superficial or deep tissues of this organ, and involving either a restricted portion or the totality of the parts concerned. Syphilis and tuberculosis of the larynx, sometimes termed "syphilitic" and "tubercular" laryngitis, are considered elsewhere in this volume.

Etiology.—In the vast majority of cases, chronic laryngitis represents but an anatomical subdivision of a chronic inflammatory disorder involving the respiratory tract, the nasal cavities—anterior or posterior—the pharynx, the tonsils—post-nasal, pharyngeal or lingual—the trachea, and the bronchi, representing as many foci. Indeed, chronic laryngitis *per se*, involving no other portion of the respiratory surfaces, is rarely met with, except in persons such as singers, clergymen, public speakers, officers, hucksters, etc., who are called upon to use their voices excessively and vigorously. Occupations such as those involving arduous labor in a dusty or smoky atmosphere are also capable of inducing a chronic inflammation of the larynx, but in these, likewise, the vocal organ is but a part of the area involved, the nose, nasopharynx, and pharynx being also kept inflamed through contact with the extraneous irritants. Gastric and hepatic disturbances, especially those caused by the abuse of alcoholic drinks, are frequent causes of chronic laryngitis, as evidenced by the hoarseness of drunkards and the laryngoscopic image presented by the larynx in such cases. Here again, however, the glottic turgescence and hyperemia but represent what might be seen along the entire mucous surfaces—the active manifestation of a general vascular engorgement.

Four prominent subdivisions of the general causative factors will best serve to clearly define the limits wherein each line of remedial measures will find its most effective application. Starting with the source of congestion most benign in giving rise to local manifestations, we have—first, contact of the mucous surfaces of the larynx with a dust-, smoke-, or fume-laden atmosphere capable of eliciting a marked hyperemia of the parts. In this class may be included smokers who indulge their habit immoderately and who spend much of their time in the vitiated atmosphere of bar-rooms, smoking-cars, etc. In these cases the mucous membrane of the entire mucous tract is, as it were, bathed in fresh smoke with each inspiration, the respiratory act thus serving to maintain the contact between the irritant and the mucous surfaces. The constitutional effect of tobacco—nicotism—enters but slightly in the causation of local congestion. The local irritation produced is further aggravated in smokers who expectorate freely, the main factor in the causation of the congestion being an abnormal dryness. In individuals who make it a practice to inhale smoke deeply, a whistling râle resembling that observed in mild asthma is frequently heard. Singers, public speakers, etc. often suffer from hoarseness after a long railroad trip, during which their organs of phonation and respiration have been exposed to the drying and irritating influence of smoke and dust. Workers in tobacco, weavers, mill-hands, etc., may be included in this category of cases. That deficient lubrication of the upper respiratory tract plays an important part in these cases is shown by the thirst which attends them. Alcoholism is thus sometimes engendered, the alcoholic beverages tending in turn to aggravate the trouble.

The second class of causes, and one which, as already stated, furnishes by far the greatest number of cases of chronic laryngitis, is represented by all disorders of the nasal cavities, anterior and posterior, which interfere with their normal physiological functions. To allow the ingress of a sufficient quantity of air, to warm the latter and rid it of its irritating particles or noxious micro-organisms, are functions which, interfered with, promptly give rise, directly and indirectly, to morbid processes in the regions which they were intended to protect. Chronic catarrhal affections, stenotic or atrophic, septal deviations or tumors, by compromising the lumen of the upper respiratory passages and reducing or arresting the outpour of nasal mucus, by limiting the powers of the ciliated epithelium, transform parts which formerly acted as guards above the larynx into centers of morbid changes. These may exert their influence directly by continuity of tissue and the irritating action of muco-purulent secretions which find their way into the larynx ; indirectly, by imposing more or less mouth-breathing—dusty, unwarmed, and perhaps septic air thus coming into direct contact with the laryngeal mucous membrane.

The third class includes the various visceral or diathetic disorders frequently overlooked as causative agents. In a large proportion of these cases the larynx but furnishes the most salient evidence of a general hyperemia of the mucous membranes. This hyperemia may be incident upon some disorder compromising the functions of the vascular system, either by causing on the one hand changes in the elements of the blood itself, or by offering a mechanical impediment to its circulation, especially in the capillaries, the result of a localized engorgement. The liver is the organ of predilection in this particular, the hepatic engorgement being in turn frequently secondary to a gastric disorder. Such cases commonly suffer also from hemorrhoids. As to diatheses, it is quite certain that in gouty subjects general treatment calculated to antagonize the effects of the dyscrasia acts promptly when local treatment will utterly fail. As regards syphilis, a chronic laryngitis occurring in an infected individual will be materially benefited and frequently cured by a course of iodid of potassium after all topical measures have proven futile. Again, cod-liver oil and iodin will do more to cure chronic laryngitis in lymphatic children than any direct medication. All these undeniable facts point to the influence of general affections upon laryngeal tissues—a point too frequently overlooked (see also page 875).

In excessive professional use of the larynx, coupled with faulty methods of tone-production, we have the fourth variety, and the most pernicious etiological factor as regards local anatomical changes. A peculiar feature of these cases is that they do not always present active symptoms, baritones and bassos frequently showing laryngoscopically every evidence of active inflammation—intense redness of the vocal bands, marked thickening of the margins of the glottis, etc.—without suffering from the least hoarseness to attract attention to the vocal organ. These cases point to the effects of overuse —namely, a localized engorgement of the superficial blood-vessels caused by intense and prolonged muscular contraction. The vessels beneath the surface being, as it were, supported by surrounding tissues, the superficial capillaries bear the brunt of the undue blood-pressure, owing to the absence of resistance afforded by their location, and become inordinately and permanently dilated. Years are doubtless required to produce this varicose condition in the average case, but an undue effort at a time when a singer is not in his usual good health may in an instant cause a vascular dilatation presenting the same redness, but attended by all the phenomena of an acute inflammation, the precursor of a tedious chronic catarrhal disorder susceptible to frequent exacerbations.

Chronic inflammatory disorders of the larynx are more frequently observed in men than in women, because they are more exposed to the etiological factors outlined than the latter. Smoking and drinking are prolific indirect causes, as stated, and these habits are most generally indulged in by the male sex. Chronic laryngitis can occur at all ages.

Symptoms.—Impairment of the voice is naturally the most prominent symptom—one but little, if at all, influenced by the nature of the primary cause of the laryngeal disorder. A sensation of rawness or tickling gives rise to the desire of hemming or hawking—a voluntary effort to rid the larynx of a supposed offending mass of mucus. The hoarseness may not be continuous, but occur only after the voice has been used for a short time. In some cases the voice is at first quite veiled or hoarse, and after a few words or sentences have been spoken it becomes temporarily clear. The vocal disability, however, is sometimes shown by a feeling of local fatigue, heat, and constriction. In singers all these symptoms may be present simultaneously, the least effort at singing increasing the trouble. The voice is usually lowered in pitch. Complete aphonia occasionally occurs. Pain is an occasional symptom, denoting the probability of rheumatic diathesis. Cough provoked by the sensation of itching already alluded to is present in the majority of cases and is occasionally spasmodic. The expectoration is scanty, however, unless tracheal or bronchial trouble is also present.

The laryngoscopic appearances vary considerably and are proportionate to the degree of active inflammation. The evidences of local hyperemia are nevertheless always present, and vary from a slight arborescent and light pink tinge, suggestive of congestion, to a bright red hue, indicative of violent inflammation. The epiglottis is also congested, enlarged vessels coming over its posterior surface, while the aryteno-epiglottic folds appear thickened, the tumefaction involving the entire larynx in marked cases. The general redness, however, is not so marked as in some cases of acute laryngitis. The vocal bands are also more or less congested ; the congestion may either be limited to a small portion of their surface or involve their entire area. Small masses of stringy cream-like mucus are frequently to be seen forming films when the glottis is opened.

In some cases the vocal bands appear relaxed and their thickened edges do not seem to come accurately together, an elliptical opening being occasionally observed between them. This want of parallelism is due to muscular paresis (see Plate 15), affecting usually but one side. Shallow abrasions of the epithelial covering are occasionally met with, especially in the interarytenoid space. Deeper ulcerations, sometimes leading to perichondritis, have been observed by various clinicians.

In some cases the secretion, besides being muco-purulent or purulent, is prone to adhere firmly to the mucous surfaces and to become partly desiccated in this situation. The dry crusts formed, by impeding the free passage of air, give rise to more or less dyspnea. Laryngoscopically examined, the larynx appears red and dry, with greenish crusts closely adhering to parts adjoining the vocal cords either above or below. Owing to the appearance of dryness, a special name, *laryngitis sicca,* is frequently given this disorder. The breath expired from the mouth is usually very fetid, hence another name, *ozena laryngis,* given it by observers who considered the disease as invariably associated with atrophic catarrh of the naso-pharynx. It is probably a rare manifestation of chronic laryngitis, but it appears to me one possessing an insufficient number of known characteristics to warrant for it a special position in our nomenclature.

Hemorrhage of the larynx sometimes occurs in the course of chronic laryngitis in connection with severe cough and copious expectoration. In a case related by Michael Pleskoff the expectoration had been bloody on several occasions. Laryngoscopy revealed the ordinary diffuse redness of the vocal bands common to chronic laryngeal catarrh; but in the region of the left vocal process, near the ventricle, there was an elongated, submucous, circumscribed bloody patch, which covered half the breadth of the vocal band, and which was evidently due to rupture of a blood-vessel. The treatment instituted consisted solely in suppression of the voice, and gradual absorption of the effused blood took place with its disappearance in three weeks.[1] Another marked case was recently reported by Compaired.[2]

The infraglottic space is frequently involved in the inflammatory process, and the mucous membrane of its walls sometimes projects slightly beyond the margins of the glottis, especially when the vocal bands are abducted. In the so-called laryngitis sicca this region is one of predilection for the formation of crusts.

Pathology.—Whatever the primary causative factor, the main pathological feature of these cases is dilatation of the vascular supply, the vessels of the bands reaching in some cases, as already stated, a condition of varicosity. The chronic character of the disease is mainly due to paresis of the vascular walls and to the hyperplastic character of the chronic inflammatory process.

In mild cases it is probable that there is merely deficient lubrication, especially when an atrophic rhino-pharyngitis represents the primary cause, hyperesthesia of the surface taking an active part in the production of the subjective symptoms.

Prognosis.—Marked cases of chronic laryngitis seldom tend toward recovery. In cases in which the disorder is due to irritation by inhaled irritating substances, the continued use of the voice and the inhalation of dust and smoke attending everyday life are as many conditions tending to keep up the trouble, if not to aggravate it. These sufferers are seldom willing or perhaps able to give up an occupation in order to counteract a disease the symptoms of which do not involve marked suffering or danger to life. This is especially the case in patients in whom the voice is not a source of livelihood, as it is in singers, speakers, etc. In the great majority of these cases, therefore, the chances of recovery are to a degree compromised by circumstances beyond the physician's control. When they are within his control, the prognosis is at once modified, appropriate treatment and a judicious change of occupation leading to recovery in many uncomplicated cases.

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[1] *Münchener med. Woch.*, Dec. 4, 1888.

[2] *Annales des Maladies de l'Oreille,* etc., May, 1896.

Cases of chronic laryngitis in which the primary causative agent is represented by some disorder of the naso-pharyngeal tract generally respond promptly to measures capable of favorably influencing the morbid process. The prognosis of these cases, therefore, depends upon that of the primary disease. The same can be said of cases in which visceral or diathetic disorder plays an active rôle as an etiological factor. Hepatic torpidity added to gastric insufficiency are with difficulty overcome, and a chronic laryngitis due to these conditions, while yielding to judiciously directed measures, frequently reappears with much greater suddenness than it departed.

The prognosis of chronic laryngitis in singers is often a question of great moment, a brilliant career being frequently at stake. Fortunately, advanced laryngeal therapeutics enable us to satisfactorily treat even the worst of these cases, provided our instructions are properly carried out.

Another question of importance is the possibility of complications during the active inflammatory process, and particularly the likelihood of a simply chronic laryngitis being transformed into benign or malignant growths or into tuberculosis of the larynx. As to benign growths it is undeniable, judging from clinical evidence. Still the proportion of benign neoplasms as compared to that of cases of marked chronic laryngitis is so small that the presence of a concomitant dyscrasia capable of manifesting itself when hyperemia is prolonged beyond a certain limit can but suggest itself. The same might be said of malignant growths until we are better acquainted with their pathology. As regards tuberculosis of the larynx, no case so far reported warrants the assertion that a catarrhal inflammation can at any time give rise to a local tubercular process. Indeed, a careful clinical study of the subject has led me to conclude that tuberculosis of the larynx is primarily due to precisely an opposite condition, local adynamia, and that what benefit topical applications afford in the treatment of "tubercular laryngitis," so-called, is in a measure due to the local stimulation produced.

Treatment.—To properly treat chronic laryngitis the predominating etiological factor of each case must be clearly determined. The local application of astringents to the larynx in a patient in whom a disordered digestive system plays the leading part can but finally prove ineffectual; the relief obtained is soon attended by a return of the symptoms. To treat the larynx alone when a nasal disorder is also present is as futile, unless the laryngeal inflammation be a mere exacerbation of a latent catarrhal process that is soon to yield of its own accord. In other words, to merely treat the larynx without seeking for the primary cause, proximal or remote, is to court defeat or to accept time as an ally in the great majority of cases. In this disease, probably as much as in any other that could be named, the removal of the active cause is the most important feature of the treatment; the application of topical remedies playing a secondary—although important—rôle in hastening the successful issue. Briefly, in cases due mainly to continued irritation of the larynx and adnexa by such extraneous elements as dust, smoke-fumes, etc., a change of habit or occupation should be enjoined; when the laryngeal disease is due to a morbid process of the nose, naso-pharynx, pharynx, etc., this morbid process should be corrected; when a gouty or rheumatic diathesis, a gastric or hepatic affection, etc., is at the bottom of the trouble, general treatment of the condition is all-important; when in singers, speakers, etc., the organs of phonation are improperly and excessively used, the paramount indication to insure success is to correct the errors. The prognosis of the case depends mainly upon the perfection with which all these indications can be carried out.

The topical measures vary but little, whatever the primary cause of the local trouble, and common to all forms is the maintenance of cleanliness, not only of the larynx itself, but of the naso-pharyngeal cavity as well. For this purpose, a drachm of bicarbonate of soda dissolved in a pint of lukewarm water serves an admirable purpose. A few tablespoonfuls of this solution being placed in an atomizer, the pharynx and larynx are freely sprayed at short intervals during two or three minutes. The balance of the solution is then employed to cleanse the naso-pharyngeal cavities, the palm of the hand being used as a dipper from which the liquid is inhaled. The patient should do this morning and evening and on reaching home from work, if his occupation happens to be one capable of causing irritation of the mucous tract. After using the warm detergent spray, the patient should employ in the same manner a solution of resorcin, 5 grains to the ounce.

To obtain contraction of the superficial blood-vessels, local applications of active astringents must be made. The most satisfactory of these is still nitrate of silver, employed in solutions varying from 10 to 60 grains to the ounce. When erosions are present the latter solution should be preferred and applied after slightly anesthetizing the laryngeal surface to prevent spasmodic contraction. A small pledget of cotton should be used, and after being adjusted in the grasp of the forceps and dipped in the solution it should be lightly squeezed between the folds of a towel to prevent dripping. When another remedy is preferred, a solution of sulphate of copper, 30 grains to the ounce, may be employed. In cases uncomplicated by erosions, etc., weaker solutions of nitrate of silver or a 10-grain solution of tannin in glycerin applied every other day, besides the measures to be carried out at home by the patient, usually suffice to bring about recovery, provided the original cause has been properly treated. Important in this connection, especially when treating people who use their voices professionally, is always to include the infraglottic region, the portion immediately below the vocal bands, in the remedial measures adopted. A peculiarity of the mucous membrane of this region is to form creases or longitudinal folds when the bands are not in extreme adduction. Upon the integrity of this crease-forming quality greatly depends the character of the voice. In the treatment of singers, local applications including the infraglottic space and calculated to reduce congestion and irregular traction upon the edges of the vocal bands will be found to control much more readily a case of hoarseness due to an acute, subacute, or chronic disorder than when the same application is limited to the upper laryngeal cavity. As soon as the regular formation of creases is interfered with, the tension upon the vocal bands becomes excessive or irregular, and there is added to the catarrhal or other anomalous local conditions present one of even greater mechanical moment.

These cases are frequently characterized by what might be termed a subacute exacerbation. The benzoate of sodium, 5 grains every three hours, usually suffices to arrest this intercurrent trouble. If the attack is a sharp one, the patient should remain at home and inhale every hour the steam of a mixture of two teaspoonfuls of the compound tincture of benzoin and a pint of boiling water. The vessel containing the water should be covered with a towel folded into the shape of a cone; into the upper opening of this cone the patient introduces his nose, mouth, and chin to better confine the benzoin-laden steam inhaled and prevent too rapid a dissipation of the heat.

In cases of long standing the superficial blood-vessels are sometimes permanently dilated to twice their normal caliber and are increased in length in proportion. Astringents here are useless. The only measure likely to procure a return of the voice is to cauterize the varicose vessels of the surface of the vocal bands. Chromic acid is the best agent for the purpose. After thorough anesthetization with a strong solution of cocain, the acid, fused by heat to the end of a covered probe, is applied to one of the bands while the patient in his effort to make a sound brings the bands in apposition, and thus renders accidental cauterization of their edges impossible. An abrasion the size of a small pea is the result, and this spot, after healing, is distinctly whiter than the surrounding parts. The applications are to be renewed every few days, each band being treated alternately, until all the areas of superficial congestion have been destroyed.

Krause[1] of Berlin, in stubborn cases occurring in singers, recommends a method considerably employed in the United States many years ago—*i. e.*, minute longitudinal incisions made with a lancet-shaped laryngeal scarificator into the hyperplastic tissues of the bands. The bleeding is slight, and rapid improvement ensues. In the same class of cases Massei of Naples recommends spraying with a 2 per cent. solution of lactic acid, used frequently, eight to ten times daily. Hygienic measures and tonics form important adjuvants.

In mild chronic laryngitis frequently attending an overworked professional vocalist, an exacerbation of the local trouble is often due, as already stated, to deficiency in the lubrication of the vocal bands. This condition is successfully combated by the administration every two hours of 10 grains of ammonium chlorid in a tumblerful of water, and the topical use of warm sprays of a saturated solution of potassium chlorid at the same intervals. The doses are so managed that the last one should be taken at least about three hours before a performance. This avoids exposure during the subsequent stage of perspiration. A lozenge containing one grain of the ammonium chlorid taken between acts is of benefit in some instances, mainly owing to its effect upon the pharynx.

Of importance in these cases is the question of rest. This is always indicated, especially in female voices, a fine voice being always endangered when it is used during a more or less grave local disorder. Our recommendation should be framed accordingly, taking the severity of the local trouble as our guide as regards the duration of the resting period and its degree. Unfortunately, rest is rarely possible in professional singers, and as long as a vestige of voice remains they insist upon a continuance of their work. What are we to do in these cases? Without doubt the most advantageous plan to all concerned is frankly to disclose to the patient the dangers incurred; to recommend abandonment of rehearsals; limitation to the smallest degree possible of the part to be sung or spoken; to transpose, when possible, all high notes, or, if this is not possible, to shorten the chest-register a couple of notes, thus changing to the head-tones without having to throw upon the larynx the strain of the two highest notes of the chest-register; in other words, to limit as much as practicable the work of the vocal apparatus.

Besides the local measures recommended, these cases require special efforts to overcome the muscular fatigue entering for a great share in the subjective symptoms. Strychnia, $\frac{1}{60}$ of a grain every three hours, and electricity are usually effective. The faradic current is most effectively employed in the following manner, which introduces water as a conductor for the current, thus avoiding the local irritation caused by contact with the electrode, and doing away with all gagging: The patient having taken what is usually called a mouthful of water—in reality, about an ounce—is told to throw his head backward and to open his mouth. The first movement of deglutition causes the water to fill the pharyngeal cavity. Light being thrown in, a Mackenzie laryngeal electrode is introduced and simply immersed in the water, the external electrode, thoroughly wetted to secure penetration through the skin, being placed over the thyroid. The circuit being then closed by pressing the button of the Mackenzie electrode, the current is allowed to flow as long as the patient can hold his breath. The mouth-electrode being then taken out, he can, either by closing his mouth and bowing his head forward, bring the water forward and take a few breaths through the nose, then renew the first movement, throwing the head backward, etc., or take another mouthful of water, after ridding himself of the first. The oftener the sittings—which should last at least fifteen minutes—are renewed, the better; the patient may even be taught the procedure, and he can then treat himself twice or three times daily at home.

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[1] *Berliner klin. Woch.*, April 16, 1894.

When there is a tendency to the formation of crusts, as in "laryngitis sicca," the benzoin-and-steam inhalations are very effective. Iodid of potassium, five grains in a glass of water after each meal, has given me the best results. Local applications of a 30-grain solution of nitrate of silver usually prevent a return of the trouble.

NODULAR LARYNGITIS, OR CHORDITIS TUBEROSA.

Etiology.—This is a disorder of the mucous membrane of the vocal bands, consisting in the development of small nodules on the surface or edge of the latter as a result of chronic laryngitis. The use of the voice while an inflammatory process is present in the larynx, a faulty method of singing, friction of the free edge of one band against that of the other where the voice is considerably used, are the main primary factors to which this disease is attributed. It is almost always observed in singers and public speakers, and more frequently in sopranos and tenors than in baritones and bassos. According to Moure,[1] this affection is frequently met with in children from seven to ten years of age.

Symptoms.—The most prominent symptom is hoarseness, or an irregular production of the voice, characterized by the escape of air simultaneously with the emission of sound. In some cases there is aphonia when the normal vocal effort is made in speaking, while sound is emitted during vigorons enunciation. In others, again, complete aphonia exists. There is usually no dyspnea, and in fact no evidence of local trouble other than the mild chronic laryngitis which is usually present in such cases.

The nodules may be situated upon either band. In the few cases I have had occasion to treat they were situated on the free edge of the left band—a mere coincidence, doubtless. In one case there was evident irritation of the same spot on the other band, caused by the friction of the nodule. In this manner secondary nodules are thought to be produced, as they are frequently symmetrically located. The growths are usually the size of a pin-head; in one of my cases, however, the growth had reached at least four times that size. The nodules are usually pinkish-gray, an areola of red, from which arborescent venules sometimes project, surrounding the base. They are said to sometimes disappear spontaneously or to become changed into laryngeal growths of another variety.

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[1] *Revue de Laryngologie*, Feb. 8, 1896.

Pathology.—The nodules are the result of inflammatory action. The hyperplasia, at first limited to the epithelium, finally implicates the tissues beneath, the changes consisting mainly in cellular-tissue hypertrophy. The epithelial elements are also largely increased.

Treatment.—I am inclined to believe that the nodules reported as removed by the local application of strong solutions of nitrate of silver or of iodin were not really nodules, but merely ampullæ or tortuous blood-vessels, such as those occasionally observed in chronic laryngitis of old standing. In *bona fide* cases, the only measures found of real service in my cases were chromic-acid crystals, the silver nitrate in its solid form, and the galvano-cautery. Either of the former two agents may be fused upon the end of a protected probe and applied to the nodules after anesthetizing the laryngeal surfaces. Of the remedies mentioned, chromic acid has served the best purpose, applied in the manner described in the section on chronic catarrhal laryngitis. Nitrate of silver and the galvano-cautery leave a scar-like tissue which might ultimately compromise a fine voice.

PACHYDERMIA OF THE LARYNX.

Although this affection is not always considered as a morbid entity, its pathological features are nevertheless such as to warrant its classification among the special complications of chronic laryngitis.

Etiology.—Pachydermia of the larynx is a disease consisting of symmetrically elongated swellings of oval shape, most frequently observed near the posterior extremities of the vocal bands, especially the region of the vocal processes. It occurs especially as a result of the chronic laryngitis observed in persons addicted to the excessive use of alcohol and tobacco, and is sometimes ascribed to tuberculosis and syphilis. Judging from the cases so far observed, it occurs most frequently in men between thirty and forty-five years of age.

Pathology.—In a series of fifteen larynges affected with pachydermia examined microscopically, Habermann[1] found connective-tissue changes in the mucosa and submucosa of the vocal cords and ventricular bands, extending occasionally into the thyro-arytenoid muscle involved (Fig. 596). In some spots, especially the vocal processes and the posterior wall (the inter-arytenoid space), individual papillæ had developed into papilloma-like growths. The cup-like prominences due, as thought by B. Fränkel, to pressure exercised by the vocal processes upon one another during phonation, were present in the majority of cases, the central depression corresponding to the point of the hyaline process. Connective-tissue strands radiated in all directions from the surface of the papillæ. The erosions and ulcers found occurred most frequently on the vocal processes, about equally on each side, less often on the free border of the vocal bands. Nothing was found to indicate that these ulcerations were due to either tuberculosis or syphilis. The association of pachydermia and ulceration with diseases which cause general congestion, pulmonary emphysema, cirrhosis of the liver, etc., was, however, confirmed.

Symptoms.—The symptoms vary according to the situation of the local thickening, but as a rule the disease runs its course unattended by any great degree of discomfort. The first symptom—huskiness—is usually ascribed to a cold, and is accompanied by frequent desire to clear the throat, owing to a sensation resembling that caused by the presence of a foreign body. Slight

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[1] *Zeitschrift für Heilkunde*, Bd. xvi., 1895, and *Journal of Laryngology*, Oct., 1896.

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dyspnea is sometimes experienced; this is perhaps due to the diminished abduction observed in these cases.

Examined laryngoscopically, the larynx appears more or less congested according to the intensity of the catarrhal process that may be present. In some cases the laryngeal surfaces, except the sites, of the growths, appear normal. On the vocal bands, however, and almost always over the vocal processes, two pink or red swellings, one on each side, and sometimes involving the posterior wall of the larynx, may be seen. One of these growths is much larger than the opposite one. In a case seen by Dundas Grant the larger tumor had reached the size of a shirt-button. The smaller thickening on the opposite side shows an excavation or depression at its apex, precisely where the growth of the other side comes in contact with it during approximation of the vocal bands. This cup-like depression, as already stated, is due to the pressure exerted by the tumor of the one side upon the corresponding tumor of the other. There may be but one excrescence, however, and indentation of the opposite be formed at the expense of the tissues of the vocal band proper.

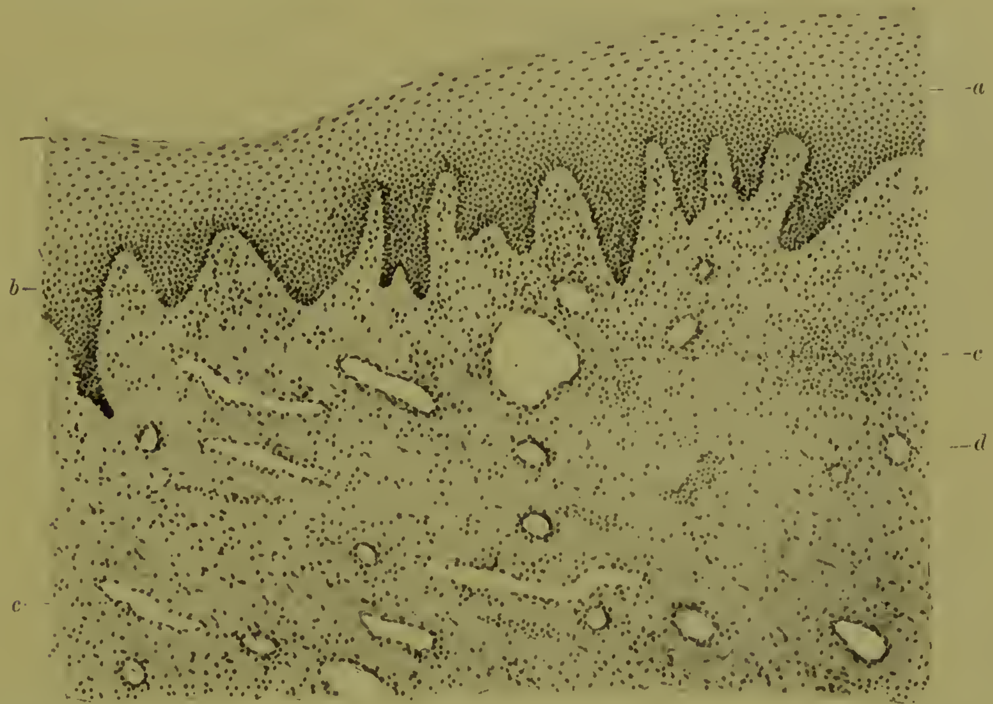

FIG. 596.—Section of mucosa, showing pachydermia of the larynx. The hypertrophied papillæ (*b*) are covered with greatly thickened epithelium (*a*), and the infiltrated submucosa (*d*) shows gaping vascular channels (*c*) (Seifert and Kahn).

Prognosis.—The prognosis of this affection mainly rests upon the possibility of transformation from a benign to a malignant growth. Klebs[1] considers pachydermia laryngitis as a possible primary stage of cancer; but this view has not been generally sustained, and the prevailing opinion is that degeneration into malignancy is not to be feared. Chondritis and perichondritis, however, have been observed; but as a rule the affection is considered a benign one, offering no special danger to life. As regards the voice, permanent impairment is likely unless the case be seen and properly treated in its early stages.

Treatment.—The measures recommended for the treatment of nodular laryngitis are probably the best to adopt, especially the local application of chromic acid. The internal administration of iodid of potassium has been found beneficial in some cases owing to the frequent association of the disease with syphilis. The local measures indicated for the treatment of chronic laryngitis may also prove of value. A spray of a 3 per cent. solution of chlorid of sodium has been especially recommended.

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[1] *Deutsche med. Woch.*, p. 537, 1890.

Removal with forceps followed by local cauterization has been advocated by Gougenheim; while Moll states that he has obtained prompt results from electrolysis, a double needle and a current of 5 milliampères being employed.

CHRONIC SUBGLOTTIC LARYNGITIS.

Etiology.—This is a rare form of chronic laryngitis in which the brunt of the inflammatory process is located in the tissues beneath the vocal bands, giving rise in this situation to more or less rapid hypertrophic changes. The nature of this disease has remained obscure owing to its rarity, but it is thought to be associated with the so-called scrofulous habit, syphilis, tuberculosis, and rhino-scleroma. According to Gordon Holmes,[1] the causes of this disease are nearly always well defined. Exposure to wet and cold, straining efforts of the voice, and excessive indulgence in spirituous liquors are, in his opinion, almost exclusively the sources of the disease. It is also allied to certain occupations in which the vocal organ is used with vigor. Of 47 cases seen, 30 were males. Reports of cases seen by other authors would indicate, however, that the disease occurs more frequently in females than in males. It occasionally presents itself as a complication of typhoid fever.[2]

Pathology.—An analysis of the microscopical examinations reported by Wedl,[3] Sokolowski,[4] and Kuttner[5] tends to show that the disease consists mainly of a chronic cell-proliferation, not only in the mucous and submucous cellular tissue, but also in the underlying muscular layer, the epithelial lining sinking into the submucous tissue in various places. This process progressing insidiously, a dense indurated mass is gradually developed, which occasionally includes the edges of the vocal bands and the neighboring tissues. It would seem that besides a dyscrasia, lymphatism, syphilis, etc., the disease requires some exciting organism, especially the typho-bacillus and that of rhino-scleroma, for its development. No bacillus special to the disease has as yet been found.

Symptoms.—The earliest symptom is hoarseness, which is generally attributed to a cold. The voice is muffled and labored, and is sometimes completely lost. This complete aphonia is more likely to occur in females than in males. The patient sometimes experiences a sensation of weight in the throat, due probably to the impediment offered by the more or less solidified subglottic tissues to the movement of the vocal bands. Pain is seldom experienced, but there is often a sensation of pricking that causes the patient to frequently "hem" to clear his larynx of a small mass of mucus which may have collected over the diseased area. Such a patient, who may perhaps experience a slight difficulty in breathing during exertion, may all at once, without the least warning, become the prey of intense dyspnea, and pass away unless immediate relief be at hand, the subjective manifestations being such as to suggest other disorders, cardiac or vascular, as the cause of death.

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[1] *Lancet*, November 15, 1884, p. 867.

[2] A. Sokolowski, *Archiv für Laryngologie*, Bd. ii. H. 1, 1894.

[3] Wedl, in Turck's *Klinik der Krankheiten des Kehlkopfes*, p. 203, 1866.

[4] Sokolowski, *Op. cit.*

[5] Kuttner, *Archiv für Laryngologie.*

Several such cases have been reported; others have been saved by timely tracheotomy. The subglottic enlargement on each side can usually be seen laryngoscopically, especially when the vocal bands are abducted, appearing as more or less rounded bulging masses varying from the dull, variegated pink tint of catarrhal hyperemia to the vivid red hue of active inflammation. In acute attacks the latter color prevails and the glottic lumen is almost occluded. When edema is a prominent factor of the case, the grayish-white color of the projecting mass suggests the presence of polypi such as those found in the nasal cavities.

Prognosis.—As may be surmised, the prognosis of such a case is not encouraging, tracheotomy or laryngotomy becoming obligatory. Even then the patient frequently perishes from gradually increasing debility unless an intercurrent disease such as pneumonia should carry him off. It is probable, however, that, discovered early, the trouble might be arrested by antagonizing any condition, occupation, overuse of the voice, etc., capable of inciting local trouble, or by counteracting the pathogenic influence of any dyscrasia that may be present.

Treatment.—Change of climate, to avoid acute exacerbations so frequently caused by damp cold, is indicated, with cessation of vocal effort and any other occupation or habit acting as exciting cause. Gordon Holmes,[1] who has obtained some cures, states that relief may be obtained from the use of cold spray inhalations, of solutions of perchlorid of iron, sulphate of copper, etc., between paroxysms, but that during the exacerbations warm soothing inhalations, impregnated with opium, conium, or stramonium, are preferable. Local applications by the attending physician of a solution of perchlorid of iron—two drams to the ounce of water—directly to the hypertrophied region are of value in mild cases. In advanced cases strong solutions of nitrate of silver are recommended. Cauterization of the parts with the galvano-cautery has been highly recommended by Voltolini; while Mackenzie advised scarification. Sokolowski recommends laryngofissure and thorough extirpation of the hypertrophied tissues.

CHRONIC TRACHEAL AFFECTIONS.

Unless of a neoplasm, the trachea may be said never to be independently the seat of a chronic affection, merely sharing in those which extend into it from the larynx above or from the bronchi below. Separate discussion is therefore needless.

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[1] *Loc. cit.*, p. 868.

DIPHTHERIA OF THE AIR-PASSAGES.

By J. H. McCOLLOM, M. D.,

OF BOSTON, MASS.

Definition.—The term diphtheria, derived from the Greek word *διφθερα*, meaning skin or leather, should be applied only to those cases of sore throat in which a membrane is found, and in which a culture taken from this membrane or near it shows the presence of the bacilli of diphtheria, or in those cases in which there is a profuse nasal discharge, a culture from which shows the presence of these organisms. In cases of laryngeal stenosis, although no membrane is visible and the cultures are negative, the existence of this membrane has been proved by autopsies and by the fact that membrane has been coughed up. The term membranous croup is a misnomer and is a relic of past ages. No such disease, as distinguished from diphtheria, exists, and the term should be erased from the nomenclature. Laryngeal stenosis in children in the vast majority of instances is caused by the presence of a membrane which is the result of the growth of the bacilli of diphtheria. Streptococci may cause the appearance of a membrane in the air-passages, but this membrane is not sufficiently thick and tough to impede the respiration.

History.—It is generally supposed that diphtheria is a disease of modern times, but Aretæus, a Greek physician of Cappadocia, wrote a description of a disease similar to diphtheria in 111 A. D. In the sixteenth century the disease was prevalent to a greater or less extent, according to written statements of the physicians of that time. In 1821 Bretonneau wrote the first full and elaborate account of the disease. After that time until 1847 diphtheria did not seem to attract much attention among the physicians of the Continent. In 1847 an outbreak of diphtheria occurred in England, which was traced to its origin at Boulogne and was known as the "Boulogne sore throat." Since that time diphtheria has been more generally recognized and more carefully studied; and for this reason, although the disease is somewhat more prevalent at the present time than formerly, yet the apparent increase is due in a measure to its better recognition.

Diphtheria was first recognized in Boston, Massachusetts, in 1859, in which year there were 19 deaths from this cause reported. From what is known of the disease to-day, it seems reasonable to suppose that if 19 deaths from a so-called new disease were reported, there must have been many cases of the same disease that were not recognized. The following year there was only one death from this cause reported in Boston. Since that time the death-returns have shown a gradual increase in the number of deaths. In 1863 and 1864, in Boston, with a population of 186,526, there were 353 and 287 deaths, respectively. From 1865 to 1874 there were very few deaths from diphtheria. In 1875 the number of deaths from this disease increased to an alarming extent. In 1881 there was quite a severe epidemic of this disease in this city, the deaths for that period numbering 802, giving a rate per 1000 of the living of 2.178. Since 1881 the number of deaths from diphtheria has varied from 285 to 878 each year. The number of cases reported in 1894 was 3019, with 878 deaths, making the death-rate from this disease per 1000 of the living for 1894, 1.803, while that of 1893 was 1.145. The most marked increase in the cases of diphtheria in 1894, as compared with 1893, occurred in the last six months of the year. The ratio of deaths per 1000 for 1895 was 1.173, and that for 1896 was 0.980.

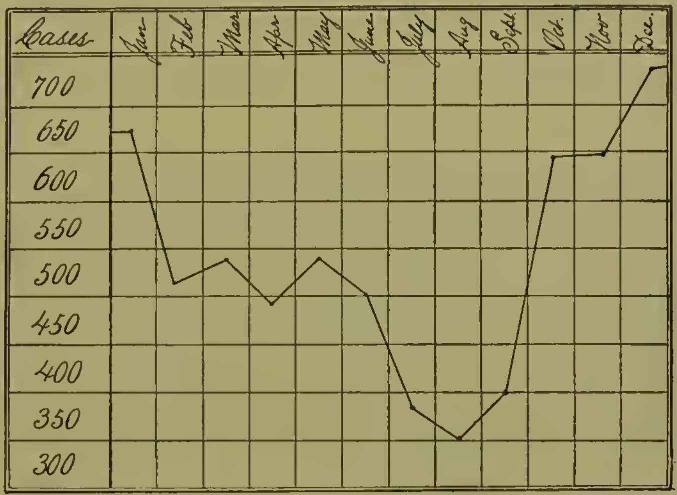

FIG. 597.—Chart of the total number of cases of diphtheria in Boston, by months, for five years.

In England the increase of the mortality from diphtheria has been much more marked in the larger towns than in the rural districts. In London this has been more particularly noticeable.

Etiology.—The discovery by Klebs of the bacillus of diphtheria in 1883 and the investigations by Löffler a year later, placed the etiology of diphtheria upon a scientific basis. The result of these researches shows conclusively that diphtheria is distinctly a contagious disease; that it never originates spontaneously; that it is a local disease; and that the constitutional symptoms are due not to the presence of the organism in the blood, but to the toxin caused by the growth of the bacillus.

It is now generally conceded that imperfect drainage and unsanitary conditions should not be considered important factors in increasing the frequency of this disease. Twenty years ago diphtheria was considered to be a filth-disease, but careful investigation of the course of epidemics in various cities and towns has shown conclusively that diphtheria is no more prevalent where unsanitary conditions exist than where the general sanitation is good.

The influence of mild cases of diphtheria in the public schools has a marked effect on the prevalence of the disease. The accompanying chart, which gives the number of cases of diphtheria reported in Boston, Massachusetts, by months, for five years, shows that when the schools are in session the number of cases is much greater than during vacation-time, in the months of July and August.

Cows may have diphtheria, and when suffering from the disease may be a source of infection. Klein, in a report to the Local Government Board of London, traced an epidemic of the disease to milk from cows that gave unmistakable evidence of being ill of diphtheria. Small areas of false membrane were found on the teats of these cows. Cultures made from these lesions contained the diphtheria-bacillus. Cats fed on the milk from these cows contracted diphtheria. While there is no positive evidence that the milk in the udder contained the germ of the disease, there is every reason to believe that the milk was contaminated by the hands of the milkers.

One factor in the spread of diphtheria is the existence of this disease in cats and dogs. Diphtheria manifests itself in cats and dogs, not by the presence of marked membrane in the throat, but by the condition of the lungs simulating pneumonia. The animal has a peculiar strident cough, has anorexia, and loses flesh rapidly. If children are allowed to play with animals suffering from this disease, they may contract it from them.

The area of infection of diphtheria is not as great as that of scarlet fever, but that it is a distinctly contagious disease must be admitted. The discharge from the nose and the secretions from the mouth may be the carriers of the contagium, hence the importance of burning or disinfecting all articles soiled by these discharges. Kissing frequently conveys the germs of the disease from one person to another.

Morbid Anatomy.—Diphtheria must be considered a local disease at the outset; and the symptoms that occur later are the result of the toxin caused by the growth of the bacilli. The growth of these organisms causes the formation of false membrane, which, according to Weigert, as stated by Councilman,[1] is due to a necrosis of the epithelial surfaces. The exudation from the vessels beneath coming in contact with the necrosed tissue coagulates and forms fibrin. Wagner[1] says the presence of the membrane is due to hyperemia and inflammation of the tissues beneath, and that there is a fibrinous metamorphosis of the epithelial cells. Heubner[1] found that in the beginning of the disease membrane was formed in the most superficial layers of the epithelial cells and gradually extended to the deeper ones. The appearance of the membrane during the first twelve hours, as compared with its appearance forty-eight hours later, is explained by this view of Heubner. The membrane in diphtheria is generally of a grayish-white color, and, as a rule, cannot be easily detached; but this is not universally the case, as frequently it is white, and appears only in small circumscribed patches easily detached. The membrane sometimes early in the disease assumes a gangrenous appearance, which is an omen of very grave import. Nasal diphtheria is characterized by a profuse nasal discharge, and it is the exception that any membrane can be detected without a rhinoscopic examination. Diphtheria of the eye, often caused by the transmission of the germs of the disease from the nose, is of frequent occurrence. There is great swelling of the lids, intense congestion of the conjunctivæ, and frequently, but not always, the formation of a false membrane. Frequently the pharyngeal inflammation extends through the Eustachian tube and causes an inflammation of the middle ear. The membrane may extend into the larynx, giving rise to marked dyspnea. Below the vocal cords the membrane is not very firmly attached to the subjacent tissues and is frequently coughed up. Fig. 598 represents membranous casts of the trachea coughed up by a patient ill with diphtheria. Casts of the right and left bronchi can be clearly seen.

Membrane may extend into the various ramifications of the bronchi. The heart may be of a grayish-yellow color, and when death occurs late in the disease, may show evidences of fatty degeneration. The kidneys, as a rule, are enlarged; and on section the cortex is found swollen and the region of the convoluted tubes opaque. When death occurs late in the disease, during apparent convalescence, there are no characteristic macroscopic lesions found, as a rule, at the autopsy. Microscopical examination, however, of the nerves shows in the majority of instances marked degeneration of the nerve-tissue.

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[1] *Boston Medical and Surgical Journal*, cxxxiii., 10, p. 231.

Prophylaxis.—The importance of isolating every case of doubtful sore throat cannot be overestimated, and it is also equally important to isolate every child who has a profuse nasal discharge, until the diagnosis can be definitely made by means of a bacteriological examination. It is a trite saying, but nevertheless true, that mild cases of contagious disease are much more dangerous to the public health than the severer ones. The writer has investigated quite a number of outbreaks of diphtheria which could be definitely traced to mild cases of the disease, cases so mild that no physician saw them. Too much emphasis cannot be laid upon the danger of permitting children with profuse nasal discharges, loaded with the bacilli of diphtheria, to mingle with others. The careful medical inspection of schools, in order that children suffering from mild attacks of diphtheria may be isolated at their homes, is a very important factor in prophylaxis. When a patient is taken ill with diphtheria, he should be placed in an upper room of the house. All hangings, stuffed furniture, and carpets should be removed from the sick-room. If possible, only one person should attend upon the patient, and she should wear cotton gowns, which should be frequently changed and disinfected. All discharges from the patient should be disinfected by corrosive

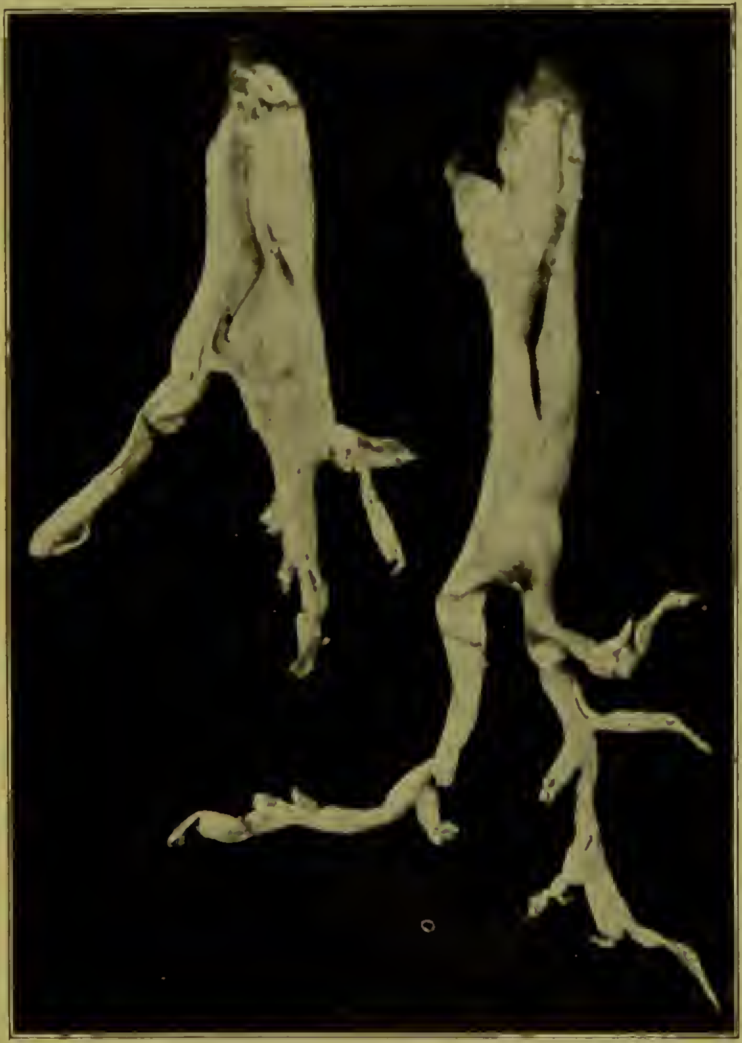

FIG. 598.—Casts of the trachea and bronchi.

sublimate, 1 part to 500, or by a solution of carbolic acid, 1 part to 20. No handkerchiefs should be used, but in place of them pieces of old cotton-cloth should be employed to receive the discharges from the nose and mouth. These pieces of cloth should be burned. All utensils should be sterilized in boiling water or by washing with a solution of corrosive sublimate, care being taken, however, to thoroughly wash them after the immersion in corrosive sublimate. The room should be well ventilated and, if possible, should have a sunny exposure. An abundance of sunlight in the room of a patient is of very great importance. The germicidal properties of sunlight have been very clearly demonstrated by v. Esmarch. In his experiments he proved conclusively that the bacilli of diphtheria in culture-tubes and on cloth were destroyed in from four to five hours. Pure air and plenty of sunlight are Nature's most effective germicides. Burning sulphur in a room where a patient is ill is a most reprehensible practice. It not only fails to do any good, but is a source of very great annoyance to the patient and nurse. The nurse should always carefully disinfect her hands with corrosive sublimate after any manipulations of the patient, and it is well to frequently wash the mouth with Dobell's solution, 1 part to 3. The physician, when making his visit, should wear a cotton gown, and should be particularly careful to wash his hands in a solution of corrosive sublimate after his visit. Careful attention to these various details diminishes the chance of spreading the disease.

After the recovery or death of the patient, the mattresses and blankets should be sterilized by superheated steam. The floors and woodwork should be washed with a solution of corrosive sublimate, 1 part to 500. The walls of the room, if painted, should be washed in a similar manner. If papered, the paper should be removed. The ceiling should be whitened or tinted. All washable materials should be boiled for an hour. Books and toys had better be burned, as there is no way of disinfecting these articles properly. The experiments of Koch in 1888 proved conclusively that sulphurous acid gas, in the manner in which it was usually employed, was useless and that this method of disinfection was misleading. It has been shown in the laboratory that various micro-organisms exposed under a bell-glass to the fumes of sulphurous acid gas for twenty-four hours have been destroyed, yet this is no proof that sulphurous acid gas is an efficient disinfectant for apartments. The conditions in the rooms of a house are entirely different from those under a bell-glass. It is impossible to make a room in a house air-tight, and for this reason sulphurous acid gas cannot be considered a reliable disinfectant in these cases. For the purpose of investigating the true germicidal value of sulphurous-acid-gas disinfection, a few experiments were made by the writer. Six test-tubes, containing each about 10 c.c. of the water from the tap, colored slightly with rosolic acid and plugged in the usual way, were exposed to the fumes of sulphurous acid gas for six hours in a room where there had been a case of diphtheria. The cotton plugs from three of the tubes were removed just before the room was closed and replaced as soon as the room was entered. It was found that the color of the rosolic acid was discharged by the sulphurous acid gas in all of them, proving that the gas had penetrated into the interior of the tubes. Cultures on gelatin-plates made from all these tubes showed a growth of the common organisms found in drinking-water. The number of colonies, however, that developed in the gelatin-plates was not so great as that which developed in the plates used for the control-experiment. In the second experiment six test-tubes—one of which contained a pure culture of the diphtheria-bacillus on cotton cloth; a second, containing a pure culture of the spirillum of Asiatic cholera prepared in a similar manner; a third, a culture of the diphtheria-bacillus in bouillon; a fourth tube, containing a culture in bouillon of the spirillum of Asiatic cholera, of the diphtheria-bacillus, and of the bacillus pyocyaneus; a fifth tube, containing a pure culture of the diphtheria bacillus on blood-serum, and a sixth tube, containing the water from the tap—were used. These tubes, plugged in the usual way and the contents colored slightly with rosolic acid, were exposed to sulphurous acid gas for six hours in the presence of moisture. As in the previous experiment, the plugs were removed from three of the tubes. The color was found to be discharged from the rosolic acid in all of them. Cultures made from these tubes were found to contain all the organisms with which the initial tubes had been inoculated, with one exception, that of the tube in which there were three organisms. In this tube the spirillum of Asiatic cholera was not found. The growth was not very abundant in the inoculations made from these tubes. It therefore seems evident from this limited investigation that, while sulphurous acid gas may possibly inhibit the growth of pathogenic organisms, it certainly does not destroy them. Chlorin gas, when evolved in the presence of steam, is one of the most efficient disinfectants, but the objection to it is the fact that it ruins all metal with which it comes in contact. Fischer has proved by his experiments that if the spores of the anthrax-bacillus were exposed in moist air to chlorin gas they were destroyed after an exposure for one hour. The disinfectant known as electrozone, which is made by the decomposition of sea-water with a current of electricity, contains a large proportion of chlorin with a small quantity of iodin and bromin. Recent experiments prove that this agent possesses powerful antiseptic and germicidal properties. There can be no doubt regarding its deodorizing powers.

Steam under pressure is now considered to be the only proper method of disinfecting mattresses, wearing-apparel, and carpets. It is important to take the precaution of removing all leather and horn buttons, as these materials will not stand the high temperature. There are various forms of steam disinfecting apparatuses manufactured abroad, and those made in this country are modelled on the same plan. Geneste and Herscher of Paris manufacture a stationary and a movable apparatus. The stationary one consists of a large iron cylinder capable of sustaining a pressure of twenty pounds to the square inch. At each end of the cylinder, which is placed in a horizontal position, are cast-iron heads moving on hinges and adapted with screw bolts, so that they can be tightly closed. A tight partition-wall separates the ends, so that there can be no communication between the room where the infected articles are put in and that from which the disinfected articles are removed. At the bottom is a coil of closed steam-pipes for the purpose of heating the interior of the cylinder; at the top is a set of perforated pipes for introducing steam. An appliance for exhausting the air to increase the penetrating power of the superheated steam is attached to the apparatus. The movable one, the prinicple of which is the same as that of the stationary, is mounted on wheels and weighs about as much as a fire-engine. The steam is generated by a fire-box at the lower part of the cylinder. Henneberg of Berlin manufactures a similar movable apparatus, which has some slight improvements over that of Geneste and Herscher. These movable disinfecting cylinders can be used with great advantage in sparsely-settled districts, but are not adapted for use in a thickly-settled locality. Numerous experiments show conclusively that a temperature of about 212° F. for one hour will destroy all micro-organisms, and, therefore, where heat can be properly applied without injury to the articles, it is the very best method of disinfection. In disinfecting by heat in one of these steam-cylinders it is important to raise the temperature to 250°, which means a steam-pressure of fifteen pounds to the square inch, for an hour, in order that the heat may penetrate into the interior of mattresses and rolls of blankets. The best method of disinfecting upholstered furniture is an open question. The only available method of accomplishing this end is by immersion in boiling naphtha for two or three hours. Although there are no reliable bacteriological experiments on this point, yet as most of the coal-oil products are disinfectants of greater or less value, and as it has been definitely settled that the thermal death-point of many organisms is about 160° F., it seems reasonable to suppose that this method of disinfection for these articles is of practical use. The vapor of formaldehyd, judging from the results of the experiments of Vaillard and Lemoine, is a germicide of some value. The apparatus required is inexpensive and its use not difficult. More extended experiments, however, are necessary before the efficacy of this mode of disinfection can be absolutely accepted.

Symptomatology.—The period of incubation of diphtheria is from two to three days. The disease is ushered in by a slight chill and a general feeling of malaise. In children the onset in certain instances may commence with a slight convulsion. There is a feeling of pain and soreness in the throat; dysphagia is not a prominent symptom at the commencement of the attack. There is a peculiar dark-red appearance of the mucous membrane of the mouth which is characteristic of the disease, and, although not always seen, yet it is sufficiently common to be classed as one of the symptoms. At the end of twelve to twenty-four hours a small patch of membrane of a grayish or dirty-white color appears. This membrane may extend very rapidly, so that in the course of twenty-four hours the tonsils and uvula may be covered by it. Sometimes the membrane becomes gangrenous and there is an extremely disagreeable fetid odor from the patient. At this stage a profuse nasal discharge may appear; and if the membrane extends and the patient becomes septic, spots of ecchymosis appear on various parts of the body. These spots of ecchymosis are of very grave import. Few cases in which these symptoms appear recover. The difficulty of swallowing now increases; the patient is in a listless condition or may be delirious. Delirium of an active type is not a common symptom in diphtheria, although it sometimes occurs. An eruption resembling scarlet fever may appear in the

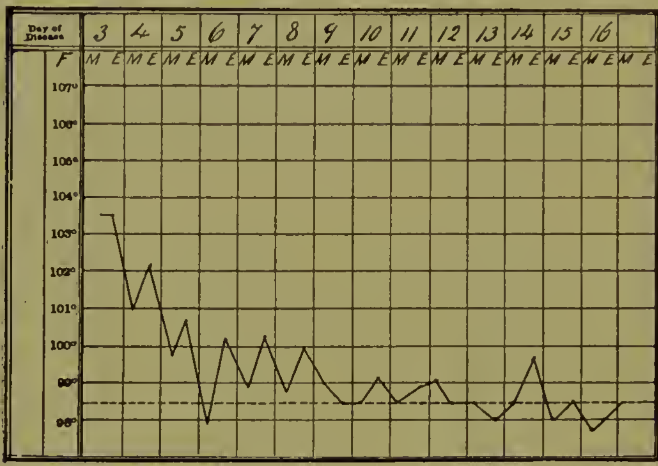

FIG. 599.—Temperature-chart in diphtheria without antitoxin.

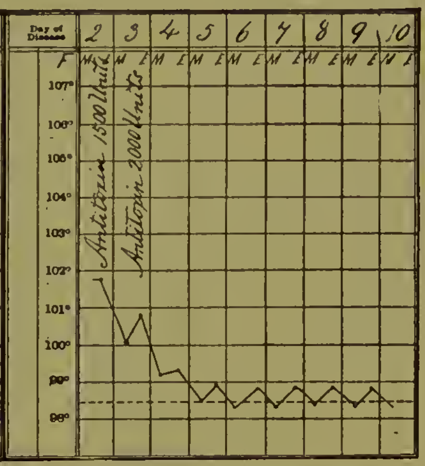

FIG. 600.—Temperature-chart in diphtheria with antitoxin.

later stages. Hemorrhages may occur from the nose and mouth. The temperature, as a rule, is not much elevated, but in certain instances, on the second or third day of the attack, may rise to 104° F. The accompanying charts (Figs. 599, 600) give the temperature in diphtheria without antitoxin and with antitoxin. In some instances the temperature may be subnormal. A subnormal temperature is greater cause for anxiety than a moderately elevated one. The pulse is rapid and weak and does not always bear any relation to the temperature. Sometimes the pulse is very slow; and when this occurs it is an indication of the profound impression of the toxin of diphtheria upon the nervous centers. There is anorexia and, frequently, nausea and vomiting. Diarrhea is frequent, but it is not a constant symptom. In the laryngeal cases it is the exception rather than the rule that any membrane is visible in the mouth. There is marked stenosis of the larynx, characterized by a cyanotic hue of the face and by marked retraction just below the xiphoid cartilage. Supraclavicular retraction is also a prominent symptom, more marked in older children and young adults. The patient is restless, is constantly opening his mouth in the vain attempt to get air into the lungs. In adults retraction of the thoracic walls is not a very marked symptom. Attacks of dyspnea may occur very suddenly in the course of a mild attack of the disease. A peculiar harsh, brassy cough is a symptom of very frequent occurrence in laryngeal diphtheria. These attacks of suffocation are sometimes relieved by the expulsion of large pieces of membrane.

In the acute stage of diphtheria death is caused by either laryngeal stenosis or by the toxin generated from the growth of the bacilli. In the later stages of the disease or during convalescence a fatal issue is due to the action of the toxin on the nervous centers. Pneumonia and broncho-pneumonia are very frequent complications in the course of diphtheria. A streptococcous infection, abscess of the cervical glands, and a purulent inflammation of the joints may occur. Inflammation of the middle ear not infrequently is observed. In the later stages or during apparent convalescence paralysis very frequently appears. Palatal paralysis is frequently seen, characterized by a nasal voice and by the passage of fluids through the nose during the act of swallowing. This form of paralysis may be so marked that there is inability to swallow a sufficient amount of food, and the patient is in danger of dying from inanition. Ocular paralysis also frequently occurs, characterized by inability to read, dilated pupil, and also in certain instances by double vision. There may also be a general paralysis, in which the patient lies in a listless state in bed, unable to raise his head or to move his arms and legs beyond a limited extent. There is sometimes a peripheral neuritis, in which the pain and discomfort are very marked. Paralysis of the pneumogastric nerve, characterized by obstinate vomiting and failure of the action of the heart, is a frequent cause of death during apparent convalescence from the disease.

Diagnosis.—The discovery of the bacillus of diphtheria by Klebs, in 1883, and the further study of this organism by Löffler, have given us a ready method of diagnosis by the aid of bacteriology. Much has been said regarding laboratory diphtheria and clinical diphtheria: clinicians having claimed that, in certain cases where the membrane in the fauces had the characteristic appearance of a diphtheritic membrane, the bacteriologists failed to detect the specific organism of the disease. As a matter of fact, from personal study of something over 3000 cases of diphtheria, both clinically and bacteriologically, it seems to me that the failure to detect the organism has occurred so seldom that it does not invalidate the accuracy of a bacteriological diagnosis. If the cultures are taken properly, if the culture-medium is in a suitable condition, and if the staining is done *secundum artem*, the failure to detect the organism very rarely occurs. A very great source of error is the fact that when taking the culture the swab or the platinum needle is rubbed over the surface of the membrane in the very position where the organisms are most likely to die. The edge and, if possible, the under surface of the diphtheritic membrane are the proper places from which to take the cultures. It is also well to take a second culture from the secretions of the mouth. In nasal diphtheria where no membrane is visible, the profuse secretion from the nose is invariably found to be loaded with the bacilli. A second source of error is the use of an antiseptic gargle a short time before the culture is taken. Practical experience has shown that when this is done the bacilli of diphtheria are not, as a rule, found in the culture-medium, although other organisms, such as cocci and streptococci, may be present.

The organism that causes diphtheria, not only in human beings but in the lower animals, is a small bacillus, straight or slightly curved, with rounded ends, having a diameter of 0.5 to 0.8μ and from 2.5 to 3μ in length (Fig. 601); or, in other words, the length of this organism is about one-half that of the diameter of a red blood-corpuscle. This organism requires a peculiar stain, which is known as Löffler's methylene-blue, consisting of a saturated alcoholic solution of methylene-blue (30 c.c.), and of a watery solution of caustic potash, 1 part to 10,000 (100 c.c.). Hunt's differential stain is of great assistance in doubtful cases. This stain is composed of a watery solution of methylene-blue, a 10 per cent. watery solution of tannic acid, and a dilute watery solution of methyl-orange as a counter-stain. When the bacillus of diphtheria is stained by this method the pole-granules are brought out with great distinctness, while the body of the organism is of a light greenish-yellow color. So far as is known, no other organism presents this peculiar appearance when stained in this way. The bacillus of diphtheria is an aërobic, non-motile, non-liquefying organism. It does not form spores, which has an important bearing on the subject of disinfection. Although this organism grows on all the usual culture-media, the growth is more characteristic on Löffler's mixture, which is composed of 3 parts of blood-serum and 1 part of bouillon containing 1 per cent. of peptone, 1 per cent. of grape-sugar, and one-half of 1 per cent.

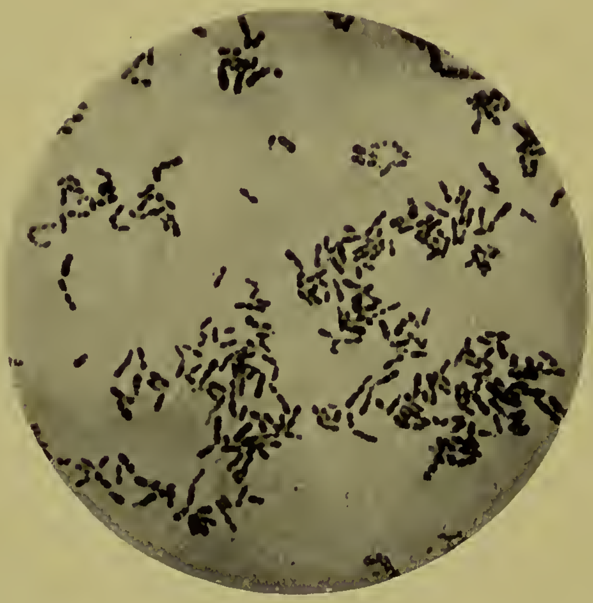

FIG. 601.—Bacillus diphtheriæ, from a culture upon blood-serum; × 1000 (Fränkel and Pfeiffer).

of sodium chlorid. On this culture-medium, at the temperature of the blood, the growth is very abundant, so that at the end of twenty-four hours small, round, elevated colonies of a grayish-white color and dry appearance will be seen. In laryngeal cases of diphtheria where no membrane is seen, cultures from the mouth invariably give a negative result. If the case requires operation, cultures from the intubation-tube or from the tracheotomy-tube, as a rule, show the presence of the bacillus. The fact that in these laryngeal cases a negative result is obtained, has led many to throw discredit upon this method of diagnosis; but a consideration of the anatomy of the parts must lead one to the conclusion that we should not expect to find the organism in these cases, for the false membrane is situated so far down in the larynx that it is impossible to reach it. Another point of interest that has been proved by clinical experience is the fact that these laryngeal cases, unless associated with nasal diphtheria, are not particularly infectious.

The statement has been made that diphtheria-bacilli may be found in the throats of healthy individuals who have been exposed to diphtheria; and while this is true in certain instances, it is so rare that very little weight should be given to it. The result of the examination of the throats of thirty nurses on duty in the diphtheria-wards of the South Department of the Boston City Hospital proved the presence of this organism in only one instance. The existence of an organism resembling the bacillus of diphtheria found in healthy throats, and known as the pseudo-diphtheria-bacillus, has been used as an argument against the accuracy of this method of diagnosis; but this organism is so seldom found that it is not a very important factor. It has also cultural peculiarities which assist in its differentiation from the true diphtheria-bacillus. Abbott has made a bacteriological study of 53 cases of simple sore throat, and in only 4 of these was a bacillus found which resembled that of diphtheria. The examination of cultures from 130 non-diphtheritic throats, made by the writer, showed that the existence of this bacillus was not sufficiently frequent to be an element of error in bacteriological diagnosis. In the cultures from these 130 throats, bacilli of many varieties were found; but in no instance was an organism seen that with care would be likely to be mistaken for the bacillus of diphtheria.

The bacilli of diphtheria may be present a long time after recovery, and when this occurs the individual must be considered a source of danger, unless it has been shown by repeated experiments on guinea-pigs that the organisms are non-virulent. The length of time that the bacillus continues after the disappearance of the membrane varies in each case. Instances are reported in which positive cultures were obtained sixty days after the disappearance of the membrane. The organism remains much longer, as a rule, in nasal cases. The average length of time is about ten days, as proved by an analysis of 1972 cases treated at the South Department of the Boston City Hospital.

Prognosis.—Diphtheria must be considered an extremely fatal disease, the percentage of mortality in severe epidemics being as high as 50. In Boston, from 1878 to 1894, the highest death-rate of cases reported to the board of health in any one year was 35.7 per cent.; the lowest death-rate for any one year was 26.44 per cent., with an average of 30.7 per cent. As these figures are based on 24,813 cases, the fatality of the disease is evident. The prognosis, even in mild cases, must always be guarded. When there is extensive membrane, profuse nasal discharge, and marked septic odor, the prospect of recovery is very slight. A gangrenous membrane is cause for an unfavorable prognosis. The laryngeal cases that come to operation, in certain instances succumb to broncho-pneumonia; in others, death is caused by extension of the membrane into the bronchi; the prognosis, therefore, in these cases, must be doubtful. The paralysis that occurs as a late symptom, if the muscles of respiration are not affected, generally ends in recovery. Failure of the action of the heart, characterized by a slow pulse, is a very grave omen; few cases of this nature recover. Degeneration of the pneumogastric nerve, characterized by persistent vomiting, irregular respiration, and a slow and irregular pulse, renders death certain. Spots of ecchymosis are very unfavorable symptoms, and epistaxis is of the gravest import. Sepsis, both in the operative and non-operative cases, is the forerunner of death. After apparent convalescence has commenced, the liability to failure of the action of the heart must be considered. Convalescence is always slow and tedious in the severer cases.

Treatment.—As diphtheria is a depressing disease, alcoholic stimulation should be commenced at the outset. The quantity of alcohol that a young child will take with positive benefit in a severe attack is surprisingly large. Whiskey or brandy must be given. It is well to commence in severe cases, in a child from one to two years of age, with a dose of from one to two drams every four hours, watching carefully the effect on the pulse and on the general condition. Digitalis should also be administered in appropriate doses early in the disease. Strychnia may be given in the later stages if there are indications of commencing heart-failure. When there is a great collection of mucus in the air-passages, atropia sometimes proves to be of great benefit. In cases of collapse the use of nitro-glycerin sometimes gives marked relief. Mercuric chlorid in small doses has been given apparently with advantage in a certain number of cases.

Antitoxin, however, is the most important agent in the treatment of diphtheria, and must be administered early in the disease. The healing-serum has been in general use some three years, and the results obtained from it are as favorable to-day as they were when the attention of medical men was first called to it. The animals that are to furnish antitoxin are rendered immune, so that the diphtheria-toxin has no effect on them. The toxin is prepared by cultivating virulent diphtheria-bacilli in bouillon for one month at a temperature of 37° C., or 98.5° F., so that the poison may accumulate. Before commencing to prepare the toxin the virulence of the diphtheria-bacilli must be tested by its effect on guinea-pigs. A procedure requiring less time has been advocated by MM. Roux and Yersin. This method consists in growing the cultures in a current of moist air. It must be borne in mind that in the preparation of antitoxin the bacilli of diphtheria are not used; but the toxin caused by their growth, the specific poison caused by them, is used. Toxin thus prepared should be of such virulence that one-tenth of a cubic centimeter should kill a guinea-pig weighing 500 grams in from twenty-four to forty-eight hours. Fränkel first rendered guinea-pigs immune to diphtheria by injecting pure cultures of the diphtheria-bacillus which had been sterilized at 70° C. Since then Behring has recommended a mixture of toxin and Gram's solution of potassic iodid.

Burger and Wasserman arrived at satisfactory results by growing a culture of the diphtheria-bacillus in a bouillon made from the thymus gland. This culture had been exposed to a temperature of from 65° to 70° C., during a quarter of an hour. The method which has given the best results is that used by Roux and Vaillard in their researches on tetanus. This consists of the addition of three parts of Gram's solution—consisting of iodin one part, potassic iodid two parts, and water 300 parts—to one part of the toxin. The injection is to be repeated after a few days, and either the dose of the mixture must be increased or the proportion of Gram's solution diminished. A little later the toxin can be given pure. It is sometimes necessary to omit the injection for a time if the animal is losing in weight.

Dogs have been rendered immune to diphtheria by many experimenters, among the number Bardach and Aronson. Sheep and goats are quite sensitive to the action of the diphtheritic poison. The immunization of milk-animals, such as cows and goats, is of particular interest from the fact that the milk of these animals has a certain antitoxic power. Of all the animals capable of furnishing great quantities of the antidiphtheritic serum, the horse is the most easily rendered immune. He bears the toxin much better than any of the animals to which allusion has just been made. By injecting gradually increasing doses of the toxin at various intervals the horse, in two months and twenty days, is rendered immune—that is, he can receive from 200 to 300 c.c., according to his weight, of toxin of definite strength without disturbance. The serum from this animal has a certain protective power, which must be determined by experiments on guinea-pigs before it is ready for use.

The curative action of antitoxin has not been satisfactorily explained; but it appears from numerous experiments that this agent does not destroy the toxin, but that its remedial power is due to stimulation or some other special action on the tissue-cells. If, however, the cells have become so damaged by the action of the toxin of diphtheria that they cannot respond to the stimulation of the antitoxin, the remedy fails to accomplish good. This is a powerful argument in favor of the early administration of the healing-serum. The remedial power of antitoxin is also restricted to a certain degree by its inability to combat the streptococcous infection, broncho-pneumonia, and other complications referable to secondary infection. In some of the experiments made for testing the action of antitoxin, diphtheria was caused in female guinea-pigs by rubbing pure cultures of the diphtheria-bacillus on the excoriated surface of the vulvæ. In these cases the pigs recovered if the serum was injected before the inoculation, otherwise they died. A membrane was formed at the point of inoculation, but there was very little constitutional disturbance. After the second day the false membrane became detached and repair of the mucous surface commenced. In these experiments the protected animals received one five-thousandth part of their weight of the serum. Other experiments were those in which guinea-pigs were inoculated in the fauces with pure cultures of the diphtheria-bacilli. Guinea-pigs inoculated in this way died in three days if not protected by the serum.

In February of 1894, after the beneficial effects of antitoxin on animals had been proved, as the preceding brief *résumé* shows, the treatment of diphtheria by this method was commenced in the Children's Hospital in Paris. During the years from 1890 to 1893, inclusive, in this hospital 3971 cases of diphtheria were treated, with a death-rate of 51.71 per cent. From February to July 24, 1894, 448 cases were treated by antitoxin, with a death-rate of 24 per cent., a diminution of more than one-half. It should be said that all the cases treated by this method were extremely severe in their nature. It must also be borne in mind that in many of the cases there was in addition to the diphtheria-infection a streptococcous infection which, as has been shown, has a nullifying effect on the benefit of the antitoxin. The effect on the local lesions in the throat was similar to that observed in the experiments on guinea-pigs.

It has been claimed by the opponents of antitoxin that diphtheria has of late years assumed a less virulent type, and that many cases are now recognized by a bacteriological examination which were not so classed a few years ago. Baginsky, director of the Emperor and Empress Frederick Children's Hospital of Berlin, states emphatically that it is untrue that since the introduction of the serum-treatment diphtheria has assumed a less virulent type. On the other hand, he says the most malignant forms have been treated by him successfully with the healing-serum. He says for the six months ending June, 1896, the percentage of mortality (excluding moribund cases) was 8.22, as compared with a mortality of 40 to 50 per cent. a few years ago. Baginsky also states that between March 15, 1894, and March 15, 1895, the death-rate in his service in cases treated by antitoxin was 15.6 per cent., and that during the time when the supply of serum gave out in the months of August and September, in the same hospital, the death-rate rose to 48.4 per cent. It has been noticed by many observers that during the warmer months diphtheria, as a rule, does not assume so virulent a type as during the colder months; and the fact, therefore, that in the former period, when antitoxin was not used, the death-rate was nearly three times as great as when it was used, seems to be a sufficient answer to the statement that antitoxin statistics are unreliable because based on mild forms of the disease. Korte says that there was an increase from 33.1 per cent. when the serum was used to 53.8 per cent. when it was not used. Ganghofner noticed an increase from 12.7 per cent. with serum to 53.2 per cent. without. Heim found that the mortality rose to 65.6 per cent. without serum as compared with 22 per cent. with serum. In an epidemic at Trieste the fatality rose to 50 per cent. when the supply of serum failed, as compared with 18.7 per cent. when it was used. As these statistics are based upon cases occurring in the same epidemics, the argument that antitoxin-statistics are unreliable because based upon the mild forms of diphtheria is untenable.

In the Boston City Hospital, from February, 1891, to February, 1894, when antitoxin was not used, there were 1062 cases of diphtheria treated, with 493 deaths, giving a percentage of 46. As this embraces a period of three years, the type of the disease might change considerably. In the South Department of the Boston City Hospital, for a period of thirteen months, from September, 1895, to October, 1896, there were 1972 cases treated with antitoxin, and of these 1706 were discharged well, 266 died, giving a percentage of mortality of 13.4. If the deaths of the 70 patients who were admitted in a moribund condition are eliminated, it would bring the death-rate down to 10.3 per cent.

Mackenzie gives the death-rate in cases of laryngeal stenosis without operation as 90 per cent. Although these cases are not stated to be diphtheria, yet it is safe to conclude, in the light of our present knowledge, that nearly all of them must have been diphtheria. Of 260 cases of diphtheria with marked laryngeal stenosis treated with antitoxin at the South Department of the Boston City Hospital, 60 were relieved of this symptom without operation; two died. The cause of death in one case was broncho-pneumonia, and in the other cardiac failure. In addition to the use of antitoxin, some of these cases were placed under steam- and others had calomel-fumigation. While these measures relieved temporarily the urgency of the symptoms, the permanent relief was due to antitoxin, judging by the experience in pre-antitoxin days. In cases of intubation, antitoxin has been of very great benefit. Waxham, of Chicago, in his monograph on intubation, states that of 150 cases collated by him, previous to the use of antitoxin, the percentage of recoveries was 27.33. O'Dwyer, of New York, the originator of intubation, reports in the *Medical Record* of October 29, 1887, 50 cases with 12 recoveries, giving a percentage of 24. As these cases occurred in private practice, it is reasonable to suppose that the operation was performed early, a condition that does not always occur in hospital practice, because patients are sent to a hospital as a last resort. In the Boston City Hospital, for the year ending January 31, 1895, there were 89 intubations and 74 deaths, giving a percentage of recoveries of 16.8. These cases did not have antitoxin. In the South Department, for the thirteen months ending October, 1896, there were 200 intubations where antitoxin was administered, with a percentage of recoveries of 46.5. If the percentage of recoveries in cases occurring in private practice where antitoxin was not used is compared with that of hospital cases at the South Department where antitoxin was used, it will be seen that the percentage of recoveries in the hospital cases is considerably larger than that occurring in private practice. If hospital cases before the days of antitoxin are compared with hospital cases after the use of this agent, it will be seen that the percentage of recoveries has been increased from 16.8 to 46.5. In intubation cases the use of antitoxin has shortened the length of time that it is necessary to wear the tube.

The question of conferring immunity on individuals who have been exposed to diphtheria, by injection of antitoxin, is a very interesting and important one. The results thus far obtained seem to prove that an attack of the disease may be prevented by the early administration of the healing serum. In an outbreak of diphtheria occurring in institutions, the immunization of all persons exposed to the disease should be strongly advocated. The time that immunity can be conferred is short, being about thirty days. A small dose, 200 to 300 units, is required.

Injurious Effects of Antitoxin.—Eruptions of various kinds following the use of antitoxin have been observed. These eruptions can be classified as urticaria, erythema, a papular eruption, and an ecchymotic eruption, which must be distinguished from the spots of ecchymosis occurring as an early symptom in severe cases of diphtheria; a punctiform eruption resembling scarlet fever, and an eruption resembling that of measles. The first four eruptions are sufficiently characteristic not to present any very great difficulties in diagnosis; but the last two so closely resemble eruptions of scarlet fever and measles that the most careful examination is required to make a definite diagnosis, and in some instances it is absolutely impossible.

In the scarlatinal form of eruption, the absence of vomiting, a normal temperature, no hardness of the palms of the hands or the tips of the fingers, the fact that the papillæ of the tongue are not enlarged, and the absence of any eruption in the throat, are the cardinal points on which the differential diagnosis must be made. In the measles-like eruption the diagnosis must be based upon its transient character; that there is no rise in temperature; that the eruption appears first on the extremities; that there is no coryza; that there is no cough; no eruption in the mouth; no eruption behind the ears. In a small number of cases joint-pains, resembling articular rheumatism, have been noticed. These joint-pains, although a source of considerable discomfort to the patient, have not been sufficient to cause any great amount of anxiety and have been followed by no serious results. In a very few instances abscesses have occurred after the injection of antitoxin; but the number is so small that it is hardly worthy of consideration, being no greater than would follow a large number of subcutaneous injections of morphia. It has been stated that albuminuria is caused by the use of antitoxin, but the observers who have made these statements have lost sight of the fact that albuminuria very frequently occurs in the course of diphtheria; and they also have not appreciated the well-recognized fact that the toxin of diphtheria may cause albuminuria, as is proved by the condition of the kidneys of guinea-pigs that have died from injections of pure cultures of the diphtheria-bacilli. Of the 1972 patients treated with antitoxin at the South Department of the Boston City Hospital, 674, or 34.1 per cent., had albuminuria, which proves that antitoxin does not increase the frequency of albuminuria, as this is not as large a percentage as occurs in cases not treated with antitoxin. In 173 cases the urine was examined before and after the administration of antitoxin. Of these 173 cases, it was found that in 99 instances albumin was absent both before and after the administration of antitoxin, which was without doubt due to the fact that the healing serum was administered before the diphtheritic membrane had increased sufficiently to generate toxin enough to cause albuminuria. In 33 cases the albumin was about the same, in 25 the albumin was diminished, which seems a sufficient answer to the claim that antitoxin causes albuminuria. In 16 cases the albumin was increased, but not to a sufficient extent to cause any special anxiety. Antitoxin has no influence on the later symptoms of diphtheria caused by the action of the toxin, such as paralysis, cardiac failure, and nerve-degeneration, but it does have a marked effect in preventing the formation of toxin and the consequent appearance of these symptoms. In Pepper's "Theory and Practice of Medicine," published in 1893, the percentage of post-diphtheritic paralysis in a large number of cases is given as 40. In the Homerton Hospital, England, of 1071 cases treated without antitoxin, paralysis occurred 125 times, giving a percentage of 11.6. Of the 1972 cases treated with antitoxin at the South Department of the Boston City Hospital, paralysis occurred in about 115 instances, 5.8 per cent. The conclusion, therefore, that antitoxin does not cause paralysis, as has been asserted, is justifiable.

In conclusion, then, it can be confidently asserted that antitoxin is a remedial agent of great value in the treatment of diphtheria; that its use does not cause albuminuria; that it does not predispose to paralysis, and that the eruptions and the joint-pains that sometimes follow its administration are not of sufficient importance to preclude its use.

The dose of antitoxin has been variously stated by different observers. The quantity must depend upon the number of antitoxin-units that the specimen used contains. As an initial dose, from 2000 to 3000 units, depending upon the age of the patient, should be given. If there is not a marked improvement in the appearance of the throat and in the general condition of the patient at the end of eight hours, a second dose should be given. If at the end of twenty-four hours the membrane has not commenced to roll up at the edges, if the swelling of the cervical glands is not diminished, if there is a profuse nasal discharge with a septic odor, a third dose should be given, and in certain cases a fourth, or even a fifth, dose may be required.[1]

The method employed by Behring and Ehrlich in testing the strength is the one now in general use in Germany. In the *Boston Medical and Surgical Journal* of December 17, 1896, Behring's method of testing the serum is thus described:

"Diphtheria-toxin is injected subcutaneously into a series of guinea-pigs

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[1] Experience has much increased the concentrated potency of the serum while proving its innocuousness; and it is recognized that poor results in the past were often due to the timid and tardy use of inadequate doses. Better results are, therefore, to be hoped for.

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to determine accurately the smallest quantity of toxin which is fatal to the guinea-pig. When this has been determined the toxin becomes the test-toxin. A given quantity of serum to be standardized is mixed with ten times the minimum fatal dose of the test-toxin and injected subcutaneously into guinea-pigs of nearly the same weight as those used in standardizing the toxin. If no local edema nor infiltration appears, if, in other words, the guinea-pig is completely protected, the quantity of serum used contains one-tenth of an antitoxin-unit. This is best illustrated by an example; the test-toxin has been standardized and found of such strength that 0.039 c.c. is the minimum fatal dose. The serum to be tested is diluted with sterile normal salt solution until 1 c.c. contains 0.0016$\frac{2}{3}$ c.c. of serum. The serum and 0.39 c.c. of toxin are mixed and injected subcutaneously. If the guinea-pig remains permanently well and shows no edema at the place of injection, 0.0016$\frac{2}{3}$ c.c. contains at least one-tenth of an antitoxin-unit. One c.c. would contain at least 60 units—that is, enough serum to completely protect 600 guinea-pigs from ten times the fatal dose of toxin. The antitoxic unit may thus be defined as being contained in ten times that quantity of any given serum which is required to neutralize ten times the minimum fatal dose of diphtheria-toxin when mixed with the latter and injected subcutaneously into a guinea-pig."

Prof. H. C. Ernst employs the following method in testing the antitoxin which he prepares. This method is described by him as follows:

"A normal toxin is one of such a strength that .1 c.c. injected subcutaneously in a guinea-pig weighing 500 grams kills the animal in forty-eight hours; in other words, kills 5000 times its weight of guinea-pig. We call a normal antitoxin a serum of such a strength that .1 c.c. injected at the same time subcutaneously in a 500-gram guinea-pig with 1 c.c. (ten times the fatal dose) of normal toxin produces no effect; in other words, protects 50,000 times its weight of guinea-pig, and is, therefore, of a strength of 1 to 50,000. This is a serum that for practical purposes is marked "dose 10 c.c.," or approximately sufficient to protect 100 pounds. When we find the serum tested in the same way of a strength of 1 to 100,000 or over, we mark it "dose 5 c.c.," an amount approximately sufficient to protect the same weight."

Many places have been selected for the site of the injection—the outer aspect of the thigh, the abdomen, the back, and the upper part of the thorax near the posterior axillary line. After trying these different places, experience has shown that the last-mentioned situation is the most desirable, because here the tissues are lax, there is no danger of entering a vein, and the patient can lie on the back or on one side without bringing any pressure on the inoculated place. If an abscess forms there is no danger of burrowing of pus, as might be the case in the thigh and back. The technique of the injection is as follows: The parts are thoroughly sterilized by washing with a solution of corrosive sublimate; a portion of the skin is pinched up and the needle plunged deeply into the subcutaneous cellular tissue, the antitoxin is then slowly injected. The puncture made by the needle is sealed by sterilized gauze and collodion. It is very important that the needle and syringe should be carefully sterilized by boiling. It is advisable to pour the antitoxin through sterilized gauze into the barrel of the syringe, rather than to attempt to draw it through the needle.

There are many different kinds of syringes in the market. Williams's syringe, which has an asbestos packing and is made of glass, is the one in use at the hospital, and it has proved to be well adapted for its purpose.

Lüer's syringe, which has a ground-glass piston accurately fitted, is a very satisfactory instrument. Koch's syringe is a very good instrument to use.

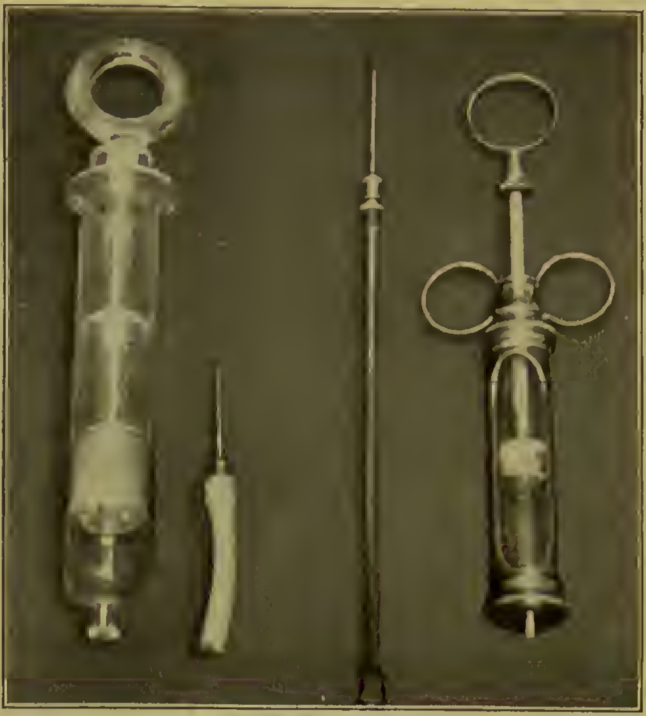

FIG. 602.—Antitoxin-syringes.

In selecting a syringe, it is well to choose one that has the needle connected with the barrel by rubber tubing. It makes very little difference what kind of a syringe is used if the different parts are made of materials that can be sterilized by heat without injury. A comparatively small needle

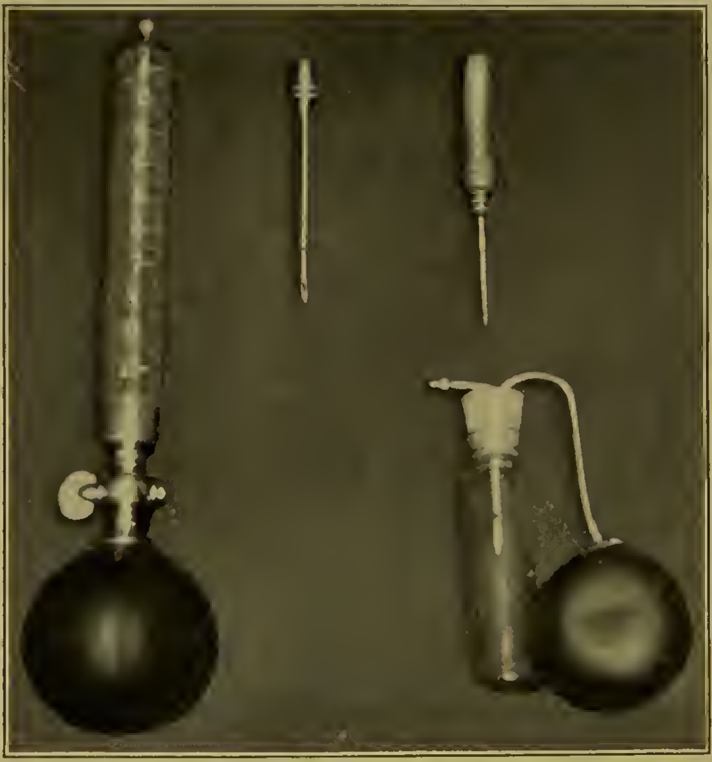

FIG. 603.—Antitoxin-syringes.

should always be used. Figs. 602 and 603 represent the two syringes in general use.

In the treatment of moderate laryngeal stenosis occurring in diphtheria, recourse may be had to the inhalation of steam. A tent can be made over the bed and the steam generated in the ordinary croup-kettle. In hospitals a special apparatus for this purpose is connected with the steam-supply. Medicated steam sometimes seems to afford relief. The following mixture, in the proportion of one ounce to a pint of water, may be used with advantage in the croup-kettle:

	Apothecary.	Metric.
℞. Olei eucalypti,	℥j	30
Acidi carbolici liq.,	℥j	30
Olei terebinthinæ,	℥viij	240.—M.

Only a moderate amount of steam is required. The debilitating effect of a continued steam-bath is very great, and this is always to be avoided in the treatment of diphtheria. The air in the canopy must be simply saturated with steam, not oversaturated, as is frequently the case. The sublimation of calomel often gives relief. A small alcohol-lamp, surrounded by wire gauze or perforated tin, with a pan on the top for the reception of the calomel, is the apparatus used. Five to ten grains of calomel are placed in the pan, and the quantity is repeated every thirty minutes for two or three times,

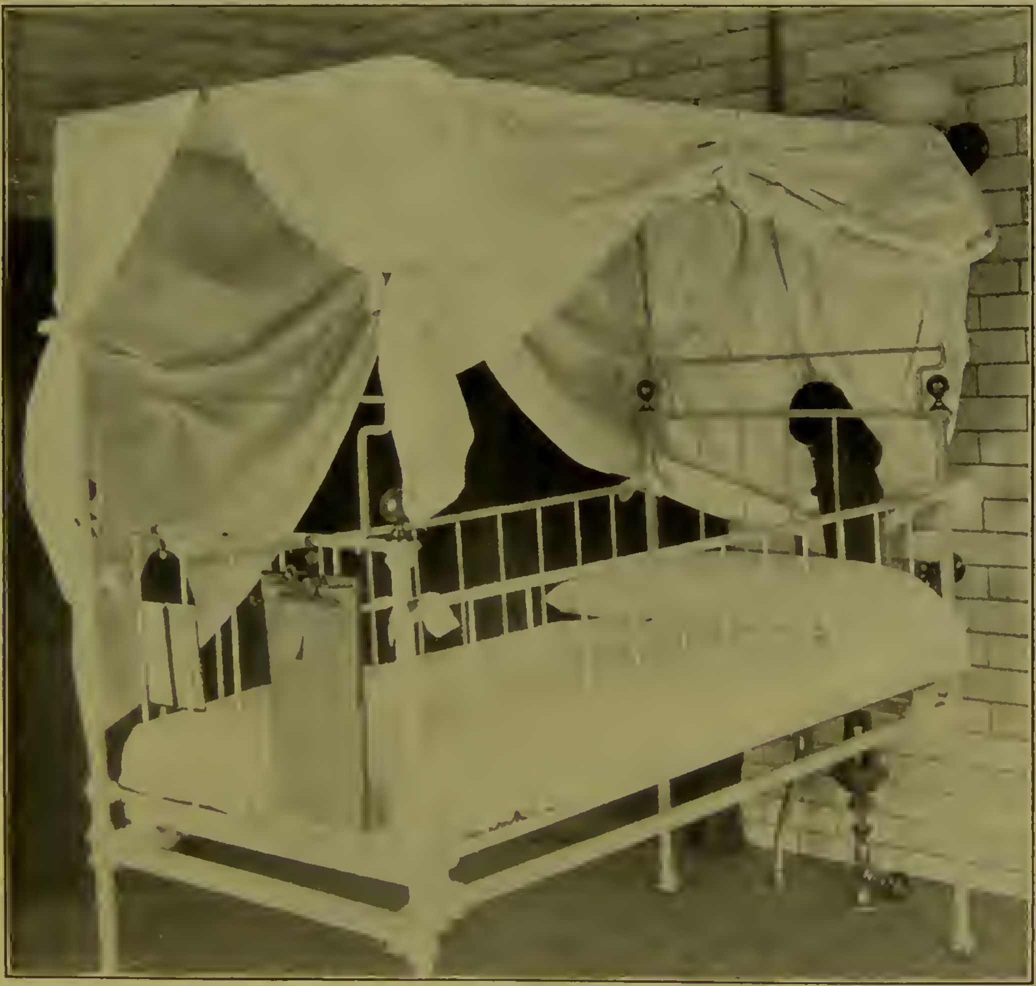

FIG. 604.—Steam-tent with sides raised, Boston City Hospital, South Department.

depending on the urgency of the symptoms. Care must be taken, however, not to continue this treatment for too long a time, as there is danger of causing salivation. Small doses of the syrup of ipecac, in addition to the measures just described, sometimes prove of benefit. Emesis, however, must not be caused.

Caustic applications to the throat have been advised, but their use is of doubtful advantage. The less the throat of a patient ill with diphtheria is irritated, the better. The experiments of Roux and Yersin show that the bacilli of diphtheria do not, as a rule, grow on sound mucous membrane, and, therefore, when the epithelium is removed by caustics and irritants, a fertile soil is prepared for the growth of these organisms. Irrigation with hot normal salt solution, or with a solution of mercuric chlorid, 1 part to 8000, or with a weak solution of chlorinated soda, every four hours, frequently gives much relief to the patient. This irrigation can be given by means of the fountain-syringe, with the patient either in the horizontal or vertical position. In nasal diphtheria the douche is of great advantage. By the irrigation all the loose membrane is removed, contributing much to the relief of the patient.

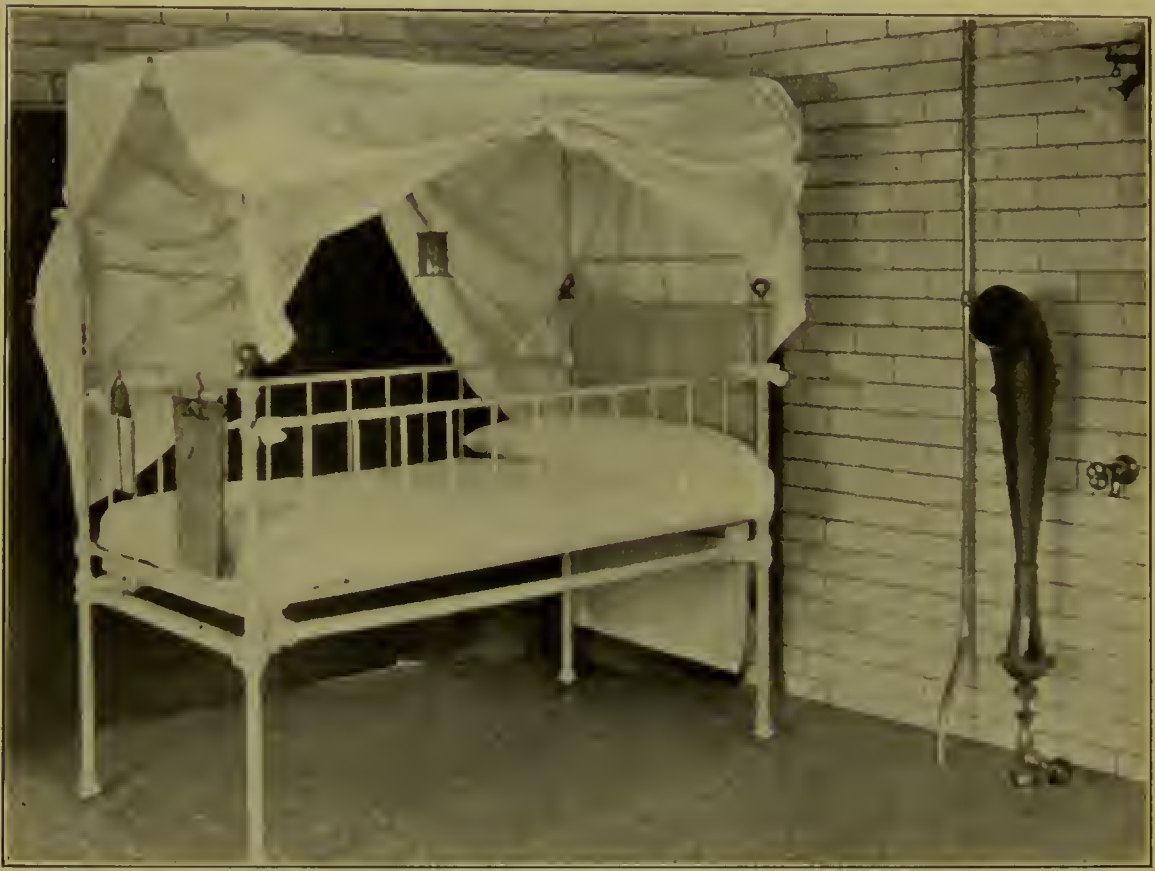

FIG. 605.—Apparatus for calomel-sublimation, Boston City Hospital, South Department.

When there is marked dysphagia, spraying the throat with a 2 to 4 per cent. solution of cocain, a short time before food and stimulants are administered, is often of marked benefit, enabling the patient to take his treatment with a certain degree of comfort.

Painting the throat with a mixture of salicylic acid, twenty grains to the ounce of glycerin, is sometimes of advantage. The application of hydrogen-dioxid is sometimes beneficial. If there is much membrane, a strong solution is required. The application should be made with a mop. The nose can be sprayed with weak solutions of one, two, or five volumes.

In order to cause the disappearance of the bacilli after the membrane has disappeared, many things have been tried, but the results have not been very satisfactory. Spraying the throat with lemon-juice or with a 5 per cent. solution of antipyrin, or with a weak solution of mercuric chlorid, or with a ten-volume solution of hydrogen-dioxid, can be tried.

In laryngeal stenosis, characterized by great restlessness, a marked cyanotic hue, distinct clavicular and sternal retraction, operative interference is demanded. The choice lies between intubation and tracheotomy. O'Dwyer's tubes for intubation are in general use in this country. The apparatus consists of five tubes, suitable for children from one year to twelve years of age; the gag, the introducer, the extractor, and a scale indicating the tube to be used for a particular age. These tubes are plated with gold. The upper end of the tube has a head that rests on the ventricular bands and prevents the tube from slipping into the trachea; in the middle there is a fusiform enlargement by which the tube is retained in the larynx. On the right side of the head is a small hole for the reception of a loop of silk. This loop of silk is to prevent the swallowing of the tube, if the first attempt at intubation is not successful. Each tube is fitted with an obturator, which is screwed to the introducer. The introducer consists of a handle and a shank; on the handle is a button, by pushing which the jaws at the end of the shank are pressed forward and the obturator disengaged from the tube. The extractor, which is curved, has at the distal end jaws which are opened by pressing on the lever in the handle.

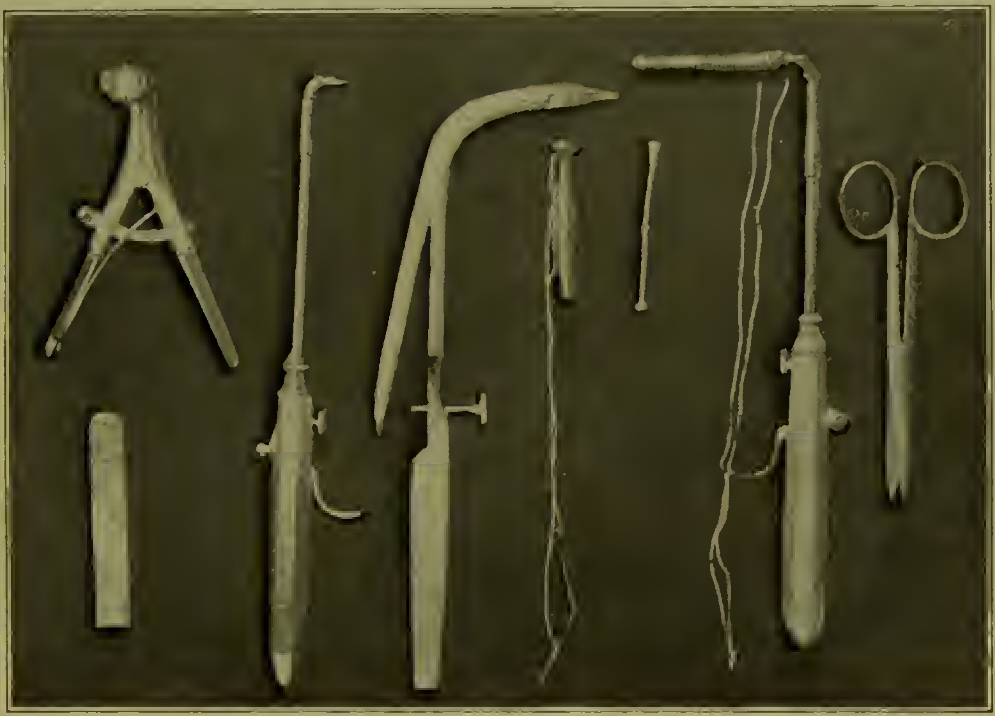

FIG. 606.—Showing the scale, the gag, the introducer, the extractor, a tube, the obturator, and the introducer with a tube attached.

Fig. 606 shows a tube attached to the introducer ready for use, a detached tube, the extractor, scissors for cutting the silk, the gag, and the scale.

Intubation is performed in the following manner: The patient is wrapped firmly in a blanket, so that he cannot move his arms, and then placed in a horizontal position, with the head slightly raised. The mouth is held open by the gag, with its jaws resting on the molar teeth. Care must be taken not to have the cheek injured by the gag, and special care must be taken to prevent its slipping. The head must be steadied by the assistant who holds the gag. The operator takes the introducer in the right hand, with the index-finger around the hook on the under surface of the handle; the loop of silk passing over his little finger and his thumb resting on the button on the upper surface of the handle. The index-finger of the left hand is then passed down to the epiglottis, which is hooked forward; the tube is passed into the mouth, with the handle well down on the chest of the patient; when the epiglottis is reached by the point of the tube, the handle should be given an abrupt turn, so as to bring the tube into a vertical position. As soon as the tube is well in the larynx the button on the handle should be pushed forward, disengaging the obturator, which must now be removed, and the tube pushed into position by the index-finger. The loop of silk is passed about the ear and the gag removed. If the tube is in the larynx, the patient will immediately commence to cough with a peculiar sound, which to be appreciated must be heard. If the breathing becomes easier; if the cyanotic hue disappears; if the retraction of the thoracic walls diminishes; if the loop of silk does not shorten, one may rest assured that the tube is in the larynx. After becoming satisfied that the operation has been properly performed, the gag is inserted a second time, the index-finger placed on the head of the tube, and one strand of the silk loop cut so that it can be removed. Remember that the finger of the operator must be a continuation of the posterior wall of the larynx; remember to make the abrupt turn; remember that no force must be used. If the tube is in the esophagus, no cough will be heard; there will be no relief in the breathing; the silk loop will commence to shorten as the tube passes down the esophagus. In certain instances intubation does not give relief, and tracheotomy must be done. If the tube becomes clogged by membrane, as is sometimes the case, it must be immedi-

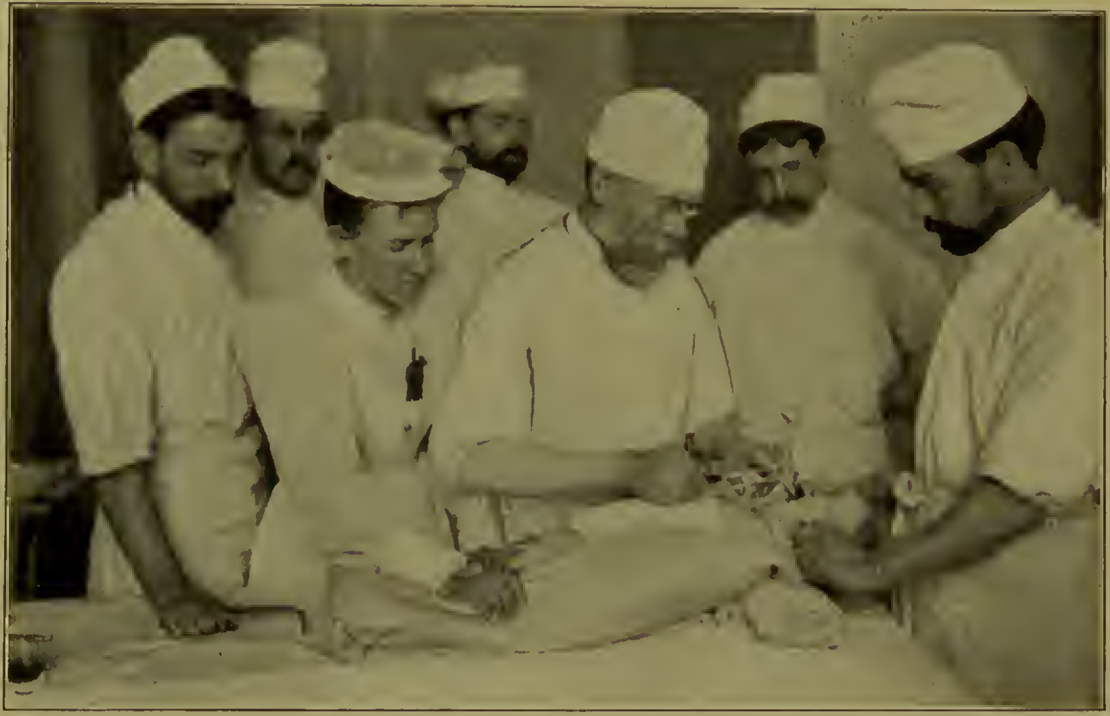

FIG. 607.—Intubation.

ately removed. The first steps of an extraction are similar to those of an introduction. The extractor is passed into the lumen of the tube and the lever on the handle pressed so as to open the jaws, and the tube extracted by a reverse of the movements in introduction. Sometimes there is considerable difficulty in extraction, but by patience and gentleness the end can be accomplished. If the child coughs up and swallows the tube, the accident may cause considerable annoyance to the physician, yet it is not of serious import, for experience has shown that the tube is passed by the rectum in from twenty-four to forty-eight hours, without causing discomfort. No definite rule can be given regarding the length of time that the patient should wear the tube. It is well to remove it at the end of the third or fourth day, but it is frequently necessary to immediately re-insert it. In some instances three or four extractions and introductions may be required. The most favorable cases are those in which the child coughs up the tube at the end of the third day and does not require re-intubation.

The operation of tracheotomy is fully described in the article on Operations and in works on surgery.

In regard to the relative merits of tracheotomy and intubation, a few words may be said. It seems to me that intubation, in the majority of cases, is the better operation: First, because there is comparatively little shock; second, because there is no open wound to become infected; third, because the air in intubation enters the lungs through the natural channels, thereby diminishing the chance of broncho-pneumonia; and, lastly, because recovery is much more rapid after intubation than after tracheotomy, there being no granulating wound to heal. In adult life, tracheotomy is, perhaps, the better operation. Bourdillat gives the following statistics of recoveries after tracheotomy, by years: Under two years, 3 per cent.; between two and two and one-half years, 12 per cent.; two and one-half to three and one-half, 17 per cent.; three and one-half to four and one-half, 30 per cent.; four and one-half to five and one-half, 35 per cent.; over five years of age, 39.5 per cent.

Waxham, in his collation of 1072 cases of intubation, gives as the percentages of recoveries after intubation, by years, as follows: Under two years, 15.62 per cent.; between two and three years, 19.46 per cent.; between three and four years, 30 per cent.; between four and five years, 32.65 per cent.; between five and six years, 33.92 per cent.; over six years, 43.33 per cent. It will be seen, therefore, that under two years of age the percentage of recoveries after intubation was five times as great as after tracheotomy; and that in only one instance was the percentage of recoveries higher after tracheotomy than after intubation, and then the increase was very slight.

It has been claimed that an intubed child could not take sufficient nourishment, that he suffered from the lack of liquids, and to obviate this condition of things various measures have been suggested, such as rectal alimentation, the use of soft solids for food, and by what is known as the Casselberry method of feeding, which consists in placing the child on its back and lowering the head, so that the pharynx is on a lower plane than the larynx. When the child is placed in this position he can take a certain amount of food with comparative comfort. Nasal feeding, however, is by far the best method of introducing food into the stomach of an intubed child. It is not a painful procedure; it is not specially difficult to perform, and one has the satisfaction of knowing just how much food, how much stimulation, and what drugs are introduced. After the second or third introduction of the tube, as a rule, the child does not struggle and does not exhibit any indication of discomfort. The apparatus in use at the hospital consists of a soft rubber catheter, in which is inserted a short glass tube, which in turn is attached to a rubber tube, and the rubber tube is connected with a glass funnel. The catheter having been well lubricated is slowly and carefully, without any force, passed through the anterior naris down into the esophagus. The funnel is elevated and about two ounces of water are poured into it, and then the requisite amount of milk, stimulants, and whatever drug may be deemed advisable to administer, followed by an ounce or two of water. The catheter is then removed quickly but gently. If the catheter is removed slowly its passage may cause vomiting, therefore it is important to remove it quickly. The condition of intubed children fed in this way is very gratifying as compared with those fed in any other way. Nasal feeding is also of very great advantage in cases of post-diphtheritic palatal paralysis, and there is no doubt that lives have been saved by adopting this procedure when it was impossible for the child to take food in the natural way. Many cases might be cited in which death might have resulted either from inanition or from pneumonia caused by the introduction of food into the air-passages, if this method of feeding had not been used.

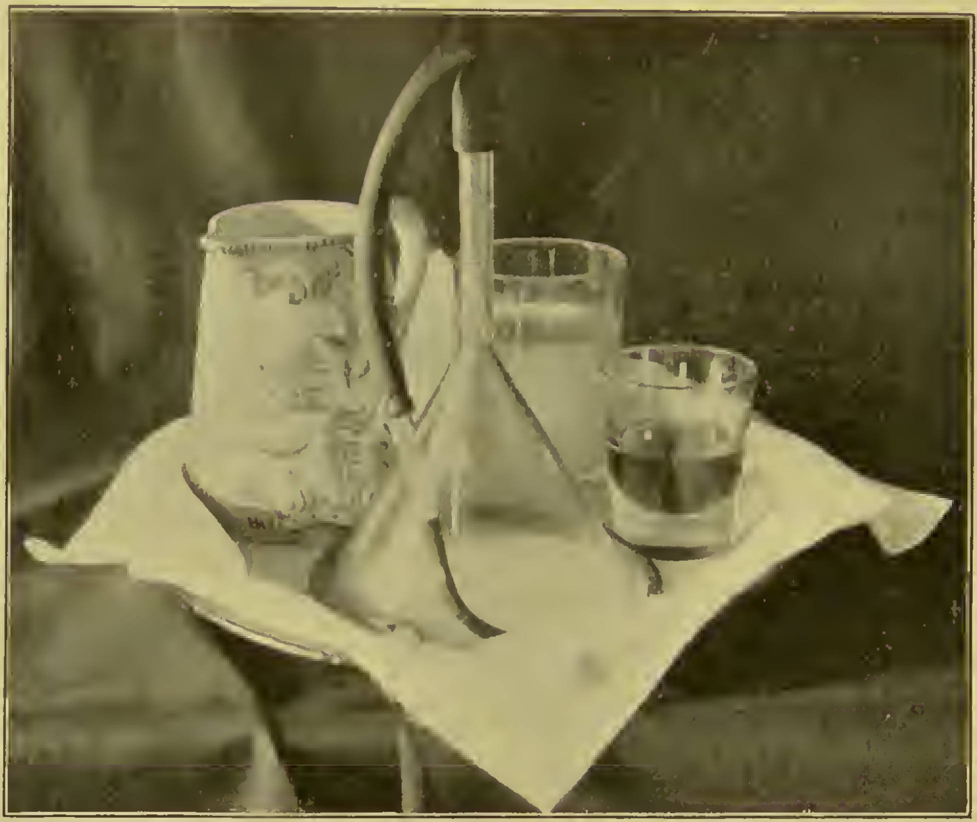

FIG. 608.—Apparatus for nasal feeding.

In diphtheria of the eye, the chief reliance must be placed on antitoxin, which should be administered heroically. The pupil must be dilated with atropia. The eye should be irrigated every two hours with a 2 to 4 per cent. solution of boric acid. In some instances the following ointment has seemed to be of use:

	Apothecary.	Metric.
℞. Hydr. iodid rub.,	gr. j	.065
Cocainæ muriatis,	gr. iv	.260
Atropiæ sulphatis,	gr. iv	.260
Petrolati,	℥ j	30.—M.

A portion of this ointment the size of a small pea should be put in the eye every eight hours. The treatment of the later effects of diphtheria on the eye belongs rather to the province of the oculist than to that of the general practitioner. The action of antitoxin on the diphtheritic process in the eye is very marked, and the results following its use are very gratifying. The greatest attention should be given to keeping the eye clean. If only one eye is affected, the other must be protected with a watch-glass. It must be borne in mind that the object of treatment is to prevent the extension of the membrane and to cause its early disappearance; therefore all irritation of the conjunctiva is to be avoided. A patch of membrane that in the throat would not be of importance, in the eye might cause blindness.

The administration of food in the treatment of diphtheria must receive careful attention. Milk is the best article of diet, and should be given in quantities as large as the patient can be induced to take. Soups and broths may also be given. Soft solids are frequently grateful to the patient. In the later stages of the disease, cod-liver oil and iron should be given. Paralysis can be treated with strychnia, massage, and electricity. In the treatment of diphtheria, care must be taken not to exhaust the strength of the patient by over-zealous attempts to induce him to take food. The practice of giving food and drugs to a patient ill with an exhausting disease, every ten or fifteen minutes, is productive of much harm, and, therefore, cannot be too strongly censured.

TUBERCULOSIS OF THE AIR-PASSAGES.

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LARYNGEAL TUBERCULOSIS.

Tuberculosis of the larynx consists of an ulcerative inflammatory process depending upon the presence and alterations of tubercular material in the soft tissues of the larynx. This material may appear as granular or nodular deposits, or as a more or less diffuse infiltration. There are two typical forms usually described: (*a*) An acute, inflammatory affection, described by Isambert and Friedländer as "acute tuberculous sore throat;" and by other observers as localized laryngeal tuberculosis. (*b*) A chronic process characterized more by infiltration and softening than by inflammation of the tissues. The former class has been by many authors considered a primary laryngeal affection, in the belief that the morbid process may originate and possibly remain in the larynx. Professional opinion, however, has been divided upon this point on account of the very frequent or almost constant implication of the lungs; although in rare instances, according to J. Solis-Cohen, no lesions have been found upon post-mortem examination in other organs of the body. The more chronic form is often denominated "secondary," because usually occurring subsequently to tuberculous disease of the lungs or other organs of the body. Between these two types there are many gradations according to the constitutional and local physical peculiarities—which also variously modify the course and character of the disease.

Etiology.—According to the consensus of professional opinion at the present time, the essential cause of laryngeal tuberculosis or laryngeal phthisis in all of its phases (as, indeed, of all other forms of tuberculosis) is the invasion of the tissues by the tubercle-bacillus of Koch; and to the action of this micro-organism is ascribed the whole pathogenesis of the disease. Although the numerous well-known and carefully-accepted laboratory experiments, besides other faithful work of reliable bacteriologists on this subject, leave little doubt concerning the accuracy of this doctrine, yet it does not supply to the clinician an adequate explanation of all the etiological or clinical features of this sometimes complex disease. While various vagaries in the vitality and growth of this micro-organism are sought to be demonstrated in the field of pathological histology in explanation of the diverse clinical effects ascribed to its presence, there still remains the knowledge of its notable failure to infect the larynx, except in from about 10 per cent. to 40 per cent. (according to various authors) of the cases of pulmonary phthisis, where certainly the conditions would seem exceedingly favorable.

The mode of invasion is supposed to be either from without through abrasions of the mucous membrane (exogenetic), or from within through the lymph- or blood-channels (endogenetic). J. Solis-Cohen believes that the invasion is from without, and infers that generally "an acute laryngitis with some desquamation of epithelium affords an inlet to the germ." But if this were so, almost every case of pulmonary tuberculosis would be accompanied by laryngeal infection for obvious reasons; and, moreover, the laryngeal disease would be apt to occur anywhere about the structure, instead of (as we observe) in selected places; while the constant application of infected sputum to a continual succession of abrasions would prove an infallible method of infection. The comparative immunity of the larynx has been accounted for in two ways. One is that tubercle-bacilli are slow in developing and need not only a *suitable nidus* but *quiescence,* conditions which the larynx, from its exposed situation and constant movement in respiration, phonation, and coughing, does not afford; and the other is, that the abrasions of the mucous membrane of the larynx are so quickly protected, either by exudate or granulations—each of which is known to be if not quite bactericidal, at least very resistant—that a proper foothold, so to speak, for the micro-organism can only with difficulty be obtained. As to the first explanation we may remark that when the laryngeal membranes are in the least degree swollen, there must be numerous abrasions from friction of the parts, for according to Rice and Hodgkinson there is continual friction between the ventricular bands, the walls of the ventricles, and the vocal cords. Regarding the question of a resting-place, there is probably no place more attractive to micro-organisms for *quiescence* than the laryngeal ventricles, where even particles of dust will remain, when mixed with leukocytes or secretion, perhaps for days, and where (being rich in lymphatic tissue) the region would furnish abundant pabulum for the growth of tubercle-bacilli. Yet it is immune.

Concerning the second explanation there is little to be said, except that the defensive effects of the reparative process in this situation are probably no more active and effectual than in similar tissues in other localities.

A few years ago Dr. Gibbes and myself scarified the pharynx and epiglottis of several healthy monkeys and applied thereto sputum from tuberculous patients, without producing in any instance local tuberculosis. We also scarified in like manner the pharynx and epiglottis (and possibly the membrane covering the arytenoids) of two monkeys suffering from pulmonary tuberculosis, without the production of local infection. In this connection I might relate that a patient of mine suffering from pulmonary tuberculosis accidentally suffered from the lodgement of a piece of chicken-bone in the pyriform sinus of the larynx. In his effort and that of others to dislodge the foreign body the pharynx was considerably wounded, as was also the aryepiglottic fold and the covering of the arytenoid and supra-arytenoid cartilages. It was with some difficulty that I was able to remove the bone, owing to the impaction of some of its spiculæ beneath the surface of the mucous membrane. As he came from a distance, considerable time had clapsed (about ten hours) between the period of the accident and the period at which I saw him, and in consequence there was considerable tumefaction of the region. I fully expected a development of secondary laryngeal tuberculosis on account of this accident, but no such phenomenon occurred. The man lived about eighteen months after this accident and was under my observation more or less of the time, but never presented any tubercular lesion of the larynx or pharynx that could be detected by the laryngoscope or by the observation of subjective symptoms. I regret to say that no post-mortem examination of the case could be obtained in order to verify microscopically this assumption. Therefore, it would seem that the moderate degree of invulnerability of the larynx to tuberculosis, or the invasion and ravages of the tubercle-bacilli, if you please, must depend for explanation upon some other hypothesis or facts than can be ascribed to either the latent or oblique behavior of the tubercle-bacillus, or to the mere abrasion of the laryngeal mucous membrane under the circumstances usually set forth. While I would not unjustly underestimate the property of latency so generally recognized as belonging to tubercle-bacilli (Bollinger has shown that tubercle-bacilli may remain latent in bronchial glands for twenty years without losing their vitality[1]), nor the modifying effects upon their growth of "tissue-reactions," yet I believe with Unterberger not only that the *rôle* of the tubercle-bacilli in spreading disease is overstated, but that the independent powers ascribed to them have also been overestimated.

Neither will the addition of the "tubercular tendency" ("congenital tendency") serve to supply completely the missing etiological link, because there are so many cases of chronic laryngeal catarrh observed in persons who possess the tubercular tendency who go through life without becoming subjects of laryngeal tuberculosis; while on the other hand, in a considerable number of cases of tubercular disease, no tubercular or "scrofulous" family history, nor event of exposure to other cases, nor history of previous severe disease can be elicited. The accession of this disease, therefore, must await some definite bio-chemical or nutritional alteration of the part, of a more or less local character, before its particular pathogenesis can be established. Undoubtedly, as Cohen says, "it is not improbable that certain bacillary elements exist normally in the tissues of the healthy individual, which under certain conditions undergo conversion into tubercle-bacilli."

Gibbes, Mittendorf, and others describe forms of tubercular tissue differing in histological characters from one another. The second author indeed asserts, upon the basis of numerous bacteriological and histological examinations, that tubercular tissue, called technically "crude" or "healthy," is very frequently devoid of tubercle-bacilli.

Regarding the so-called secondary variety there can be no doubt that the toxic agent arrives at the larynx through the lymph-channels, and depends for its local development upon the continuous and enduring alteration of the cellular elements either created or maintained by the lympho-cellular metabolism which belongs to the general disease, whether the tubercle-bacilli or some specifically depraved cellular or protoplasmic elements be regarded as the initial ferment or not. In the light of recent investigation upon the nature and powers of the various proteids of the animal body in health, as well as in disease, it is, of course, very difficult to understand the early steps in the development of *any* general disease of an infectious or septic character; especially as the exact relation of the microphytic ferments to the various proteids upon which they are supposed to operate has not yet been definitely settled.

"The effect on the body-cells of the presence and growth of tubercle-bacilli varies considerably and depends upon the *number* and *virulence* of the germs present, the *character* of the tissue in which they lodge, and the *vulnerability* of the *individual*" (Prudden and Delafield).

Ever since Virchow pointed out the wonderfully independent and specialized functions of the cellular elements of the body, both physiology and pathology have made important progress; but as yet the real mutations, both in health and disease, of these incessantly working components have escaped positive or complete detection. Their exact source and manner of regeneration are as yet unknown, as well as the definite chemical composition of all

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[1] *Brit. Med. Journ.*, Oct. 17, 1896, p. 64.

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their various protoplasmic contents; while their relation to, and influence upon, the body-fluids, such as blood and lymph, are still to a great extent subjects of speculation. Hence, until further progress is made in this direction, we shall be unable to say whether chemical changes in *them* precede or follow the presence and operation of bacteria; in other words, whether toxins or bacteria constitute the initiation of morbid processes, and whether the defensive or immunizing agency resides altogether in the mobile or fluid tissue (blood and lymph), or partially or essentially in the formed tissues and secretions of an apparatus or organ.

Of predisposing causes of the so-called inflammatory varieties, the most striking are undoubtedly frequent attacks of acute and chronic laryngitis. Consequently such cases show much variation in their course, according to the circumstances of the previous disease and the amount and extent of local inflammation of the larynx. The local disturbance, of course, is very much aggravated if accompanied by miliary tuberculosis (in which event it is apt to be very rapid and extensive); also if connected early with pulmonary lesions of even limited area, such as localized broncho-pneumonitis (Cohen) or broncho-pulmonitis. But with the latter class of cases the march of the local disease is usually slower and milder.

Tuberculosis of the pharynx or tongue may in rare cases extend to the larynx. The larynx may also become infected from tuberculosis of the tonsils, which it is said (Hans Ruge) occurs much more frequently than is supposed, and is difficult to demonstrate clinically because ulceration is so often absent. An extension to the larynx from the cervical lymphatic glands may occur—although, perhaps, not frequently—also from tuberculous caries of the teeth. Schatz has reported cases of tuberculous caries of the teeth with involvement of the cervical glands where tubercle-bacilli were found in the cavities of the teeth, while their floors showed microscopically granular tissue containing giant cells.

Constitutional syphilis and the excessive use of alcohol are common determining factors in the origin of laryngeal tuberculosis. Indeed, the former disease may occur concurrently with it.

Inordinate and improper use of the voice is also a common predisposing factor.

Age.—Laryngeal phthisis is generally observed in persons between the ages of eighteen and thirty-five years. It may occur, however, in infancy or childhood (Cohen, Beverly Robinson, Bosworth), or rarely in old age (Bosworth) as a primary affection.

Sex.—Males are more liable than females to suffer from the disease; a fact so striking in relation to the occupation and domestic or social history of the two sexes in general, that one is led to place even additional emphasis upon the exogenetic over the hemogenetic or endogenetic sources of the morbid process.

Occupation.—Vocations requiring the use of the voice in the open air (peddlers, etc.), exposure to noxious or dust-laden air, or frequently alternating variations of temperature, or confinement in close rooms, offices, or shops are predisposing causes.

Pathological Anatomy.—The earliest appearances in the so-called inflammatory varieties are those of hyperemia. The capillaries are enlarged and more or less stuffed with blood-corpuscles (Gibbes). Into the surrounding tissue there is soon effused an abundance of leukocytes and small round cells, while the mucous glands are swollen with serum and the same cellular products, so that their acini become either obliterated or distorted by pressure. Here and there, after the disease has progressed, may be seen tubercular granula in the stroma without necrosis (Delafield and Prudden), either coalescent or more or less discrete; and distinct nodular formations of granula, perhaps with reticulated surroundings, may supervene as a result of productive inflammation or tissue-reaction. There become manifest in places attempts at organization instead of necrosis, or *vice versâ;* the latter process, however, finally occurs from the subsequent obliteration of vascular supply through turgescence of lymph-channels and capillaries. According to Wright, productive inflammation and the formation of depraved granulation-tissue are apt to precede the necrosis in most instances. The mucous glands, which at first are excited to yield extra secretion, are soon compressed from without or invaded by infiltration products. The productive inflammation may lead to the formation of a granulation-tissue, which in spots will endure for quite a time; but the majority of such patches ultimately break down—ulcerate. Giant cells may not be found in the granulation-tissue in some cases; and, excepting in the undoubted "miliary" forms, where extensive ulceration or caseation rapidly supervenes, tubercle-bacilli may also be absent.

When the morbid process is localized, the surrounding tissue shows an active formation of connective and fibrous tissue with increasing vascularization—Nature's attempt undoubtedly to throw out a barrier. The zone of tissue nearest the seat of disease is well filled with small round cells and leukocytes in rather compact order. The pathological process is, as a rule, at first confined to the subepithelial layers, but soon involves the submucosa or even the deeper tissues. When softening occurs it is usually from below toward the surface, resulting in ulceration. The confinement of the caseation products, so as to produce what may be termed abscess, but rarely occurs; although after solution has taken place more or less pus, together with mucus, may be seen in the tissues as well as upon the surface. The epithelial layers of the mucous membrane suffer greatly and are entirely changed in their histological characters, both as to shape and dimensions.

In the infiltration form (see Fig. 613) there is a state of anemia, the capillaries are not increased either in number or caliber, but the lymph-channels are enlarged and filled; the mucous glands are also filled with serum and lymphoid cells, which form the basis of the so-called tubercle-granula, as well as round cells, which also fill the interacinous spaces. The epithelial layers are thinned and uneven from distention—perhaps more marked in the arytenoid region and epiglottis, where distention may be greater. At or near the sites of ulceration the epithelial layers are either lost or merged into one heterogeneous layer. Softening may quickly occur and the tissue break down rapidly to the surface of the perichondrium, even involving that structure; although it is apt to be checked by attempts at repair through the formation of granulation-tissue. The detritus from the ulcers usually shows an abundance of tubercle-bacilli, pus, mucus, altered epithelial cells, and epithelioid bodies.

The regions usually first affected are the arytenoids, posterior wall, ary-epiglottic folds, and the epiglottis, although the ventricular and vocal bands may be simultaneously involved. The ulterior ravages of the disease, if the patient lives long enough, may include any of the cartilages of the larynx (see Fig. 615).

Symptoms.—The early **local symptoms** are usually such as belong to persistent chronic laryngeal catarrh, and are of slow accession, unless, of course, the type of the disease be acute or it be a concomitant of general miliary tuberculosis. These symptoms consist of more or less hoarseness, sense of uneasiness or dryness referred to the larynx, varying degrees of tenderness, and short, hacking, laryngeal cough. As the disease progresses there is soon added more or less pain in deglutition (odynophagia), and still later difficulty of deglutition (dysphagia) and painful and difficult phonation (dysphonia), or extinction of the voice (aphonia).

The severity of these clinical signs varies greatly, of course, according to the extent, progress, and seat of the morbid process; since, for instance, limited and unabraded infiltration or nodules, as a rule, give rise to less pain than more extensive and ulcerated lesions. Lesions of the epiglottis and arytenoids produce pain and embarrassment of deglutition much earlier than those situated at the aryepiglottic folds, vocal bands, or posterior wall of the larynx. Considerable infiltration of the interarytenoid region may exist without giving rise to much discomfort. The degree of suffering experienced will be according to the amount of ulceration and swelling of the larynx and the involvement of the neighboring lymphatic tissue, and may reach such a condition that the patient will dread to swallow, cough, or speak. We sometimes meet with odd cases, however, which show a comparatively anomalous degree of insensibility of the parts throughout the whole course of the process. These cases are usually secondary to pulmonary tuberculosis.

In the type of cases characterized by extensive infiltration and anemia of the tissues, the local subjective symptoms are less marked—excepting, perhaps, dysphonia or aphonia—owing undoubtedly to the lesser degree of inflammation present. The sensibility of the laryngeal tissues may be somewhat obtunded in many of these cases. There is, however, a marked degree of embarrassment of the vocal function and often mechanical obstruction to respiration. In any case, when the vocal bands escape implication, the change in the voice is of a less decided and progressive character.

If the pharynx be involved the distress and pain in deglutition is aggravated—the pain extending to the ears and perhaps to the face and teeth. Patients often complain of a sharp pain over the pectoral region of the chest, on the side corresponding to the most affected side of the larynx. This is probably due to the connection of the short thoracic nerve with the laryngeal through the central sensory centers.

The cough is often of a peculiar stridulous or rattling character, and when causing much pain is repressed as much as possible by the patient. The amount of expectoration varies greatly, according to whether there is much softening or ulceration of the tissues going on; but after the first stages there is usually considerable expectoration of mucus and saliva—often mixed with more or less pus and streaked with blood. A certain degree of immobility of the larynx, as a whole, is usually observed, which may be due to infiltration of the lymphatic glands in the neighborhood of the muscles or through the unconscious effort of the patient to escape the pain attending its movement. The suffering of a patient with extensive ulceration of the laryngeal structures is excruciating, and toward the last, even the act of breathing, as well as speaking and swallowing, may amount to torture.

The **constitutional disturbance** in the acute varieties takes place early, so that even before the appearance of marked laryngeal disease—debility, slight emaciation, more or less insomnia, limited anorexia, hyperpyrexia, a rapid pulse, and frequency of respiration may be observed. Indeed, so insidious is the attack sometimes that the serious import of the hemming, hacking, and throat-uneasiness, coupled with poor appetite, restless nights, debility, etc., may go unrecognized for quite a while, especially when, as is often the case, the complexion and display of personal ambition of the patient seem to remain unchanged. I have known several cases of this sort in whom ambitious tyros have mutilated the turbinals in the belief that these unoffending adnexa were obstructing respiration and otherwise preventing the well-being of the patient.

In one such case brought to me for consultation after severe sanguinary surgical attacks had been made upon the turbinals and nasal septum, there were no subjective symptoms of laryngeal disease worth noting; and yet laryngoscopical examination showed a considerable infiltration of the left arytenoid region with corresponding infiltration at the apex of the left lung.

Another case worth alluding to briefly was that of a young girl of eighteen years, of ruddy complexion and plump appearance, who had been complaining for about two months of debility, slight dyspepsia, anorexia, and a very moderate hacking cough with soreness of throat, and whose voice was but very slightly altered. Examination showed slight swelling of the arytenoid region and very slight evidences of condensation at the upper right lung. Further infiltration and ulceration of the larynx rapidly supervened, and she died four months after. Such cases are also treated sometimes as "malaria!"

The anemic, diffuse, infiltrating type of the disease is usually preceded for a considerable time by constitutional symptoms of unmistakable significance, although exceptionally these cases may have been long preceded by symptoms of pharyngo-laryngeal catarrh only, without showing much systemic disturbance. As before remarked, there are many gradations of severity giving rise to corresponding modifications in the symptomatology. But too much confidence must not be placed in the apparent mildness of the symptoms as a basis for prognosis.

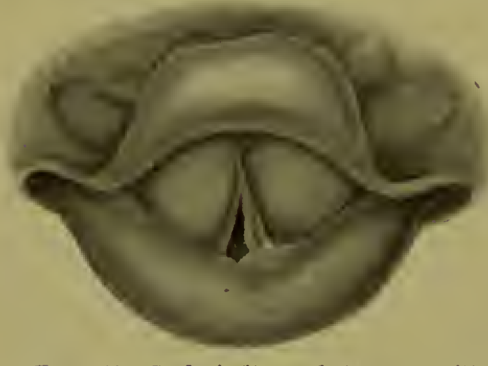

FIG. 609.—Red, infiltrated larynx with ventricular bands swollen almost into contact, hiding the right cord and most of the left, the base of which is covered by a nodule on the arytenoid (Grünwald).

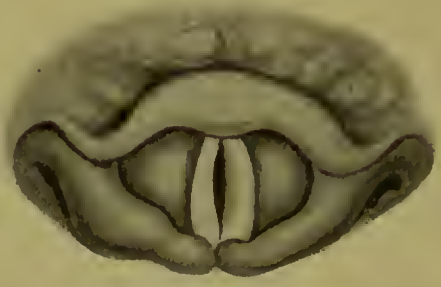

FIG. 610.—Early tuberculous nodules of the epiglottis and arytenoids with a paretic right cord and an injected margin of the left (Grünwald).

Besides, a large number of these cases show exacerbations and remissions which greatly alter both the subjective and objective symptoms from time to time. As a rule, however, when a patient exhibits persistent alterations of voice, with cough and other symptoms relating to the larynx, together with nocturnal elevation of temperature, frequent pulse, and otherwise unaccountable debility and malnutrition, the actual advent of laryngeal phthisis may be suspected, whether the physical signs elicited from an examination of the chest are corroborative or not.

In a large proportion of cases, especially if advanced, the tubercle-bacilli may be found in the sputum; but early in the disease, especially when more or less localized, this micro-organism will very often not be found, however carefully the search may be made.

Objective Symptoms.—The laryngoscopical appearances belonging to laryngeal phthisis or tuberculosis may, for purposes of description, be presented in five groups. The first (see Fig. 609) includes those cases which resemble chronic laryngeal catarrh somewhat, and are characterized by more or less diffuse hyperemia, inflammation, and swelling of the mucous membrane. The intensity of the hyperemia and swelling, however, is generally confined to either the base of the arytenoid bodies and interarytenoid space, the epiglottis, or, exceptionally, to the aryepiglottic folds, ventricular and vocal bands. The latter, however, are not affected to so great an extent by tumefaction, on account of their anatomical character. The tumefaction is not at all evenly distributed, but preponderates in one region or another. The more acute as well as localized varieties show this appearance very soon, and small roundish ulcers appear sometimes over the vocal cords near the posterior vocal processes first, or upon the epiglottis or toward the bases of the arytenoids very soon. They may be many in number or only two or three.

The second group of cases is marked also by hyperemia (see Fig. 610), but more localized; and the tumefaction may affect either the epiglottis or the arytenoids, generally the latter region particularly. These parts appear as pyriform or "club-shaped" swellings of brownish-red color, with the deeper tint toward the base. The vocal bands are usually a grayish- or brownish-white. The infiltration of the tissues may not be extensive, at first affecting mostly the arytenoids and aryepiglottic folds. The tumefaction gives to the parts in the laryngoscopical image a rather tense, smooth appearance, of a yellowish-red or salmon color, until ulceration supervenes, when the color may grow even paler, with reddish blotches. The epiglottis may be the part most affected in such cases, and is never so intensely colored as adjacent parts.

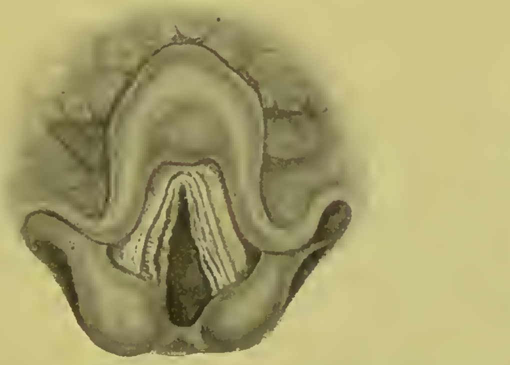

FIG. 611.—Infiltrated larynx with injected ventricular bands, the left cord nodular and the right apparently divided by an ulcer along its entire margin. Pyriform tubercular swelling of the arytenoids (Grünwald).

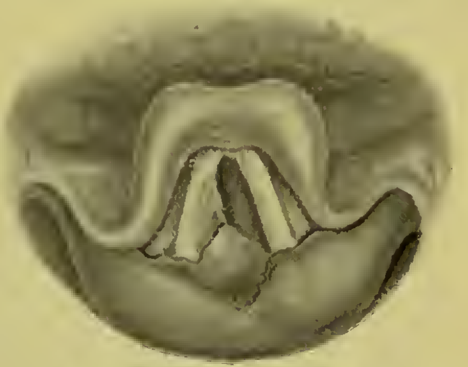

FIG. 612.—Tuberculous infiltration with tumor-formation between the pyriform arytenoids and on the right cord (Grünwald).

The third group (see Fig. 612) comprises those cases which are slow and attended with exacerbations and remissions. The color of the mucous membrane varies from a salmon to a dark red or brick red, while the tumefaction presents itself in rugæ, folds, or projections (tumors). One or the other arytenoid body is more or less fixed in position and usually bounded by ragged or papilla-like projections. The vocal bands are thickened, roughened on their edges or surface, and of a dirty-gray or brown color. Many vegetations simulating papillomata may jut out from around the base of one or the other arytenoid body, or from the interarytenoid space, the epiglottis, or the vocal bands. The edges of the latter may appear notched, either from actual ulceration or from the effects of former ulceration, granulation, or cicatrization of the same.

The fourth group includes cases of diffuse tubercular inflammation (see Fig. 613). The mucous membrane appears in the image pale, bloodless, swollen, and glistening. The tumefaction varies in degree and extent, and like other forms it may be more marked at the arytenoid bodies, which will then show the "clubbed" appearance, or at the epiglottis, which will then show the "turban-like" appearance (see Figs. 613, 614). The swelling may be so great as to give the appearance of edema, and may entirely obscure the

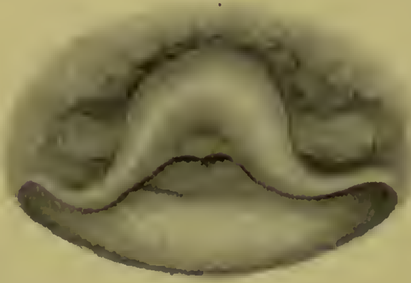

FIG. 613.—Diffuse infiltration of the posterior wall of the larynx, hiding all configuration of the arytenoids and the subjacent structures (Grünwald).

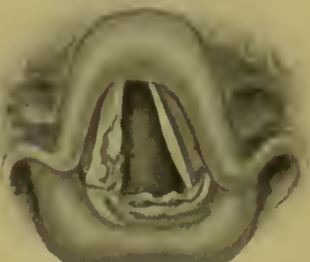

FIG. 614.—Pale larynx with swollen and roughened posterior wall and cicatricial changes about the left vocal cord, while destruction is still advancing on the right (Grünwald).

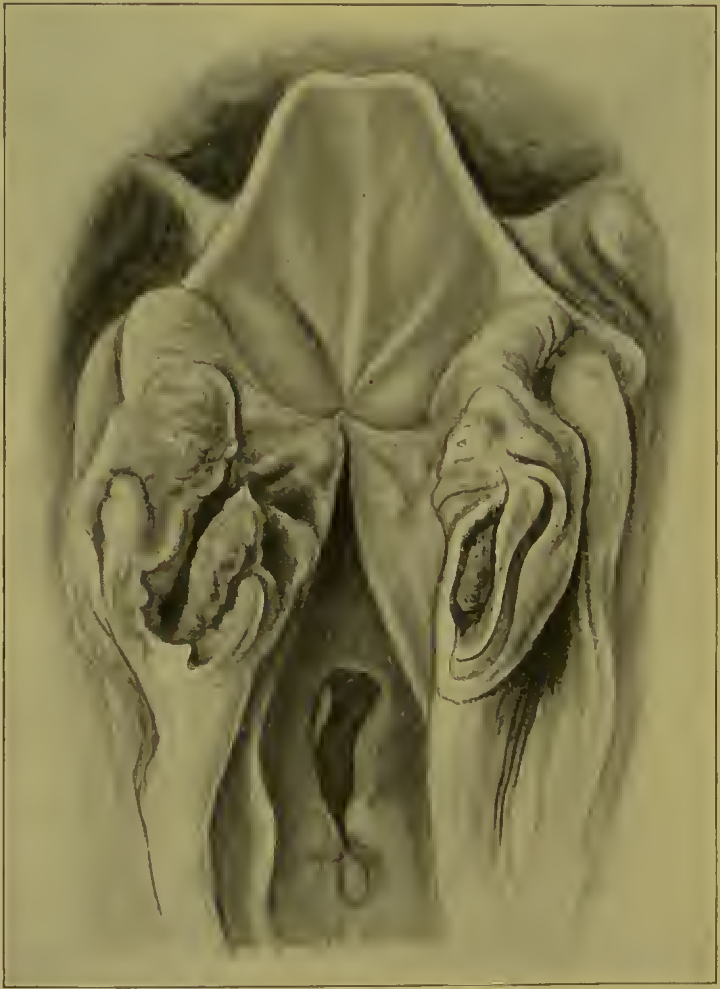

FIG. 615.—Larynx opened from behind, showing necrosis of the cricoid with ossified sequestrum and marked tubercular infiltration of adjacent structures. The ulcerated tracheotomy-opening is conspicuous below (Grünwald).

view of the interior of the larynx. The ulcerations are likewise small, and may be numerous, close together, or scattered; they are roundish or lenticular in shape until the deeper structures become involved, when they assume various shapes with ragged edges. When situated on the edge of the epiglottis, that appendix appears as if gnawed or "worm-eaten."

Group five (see Fig. 615) shows the results of extensive ravages in the advanced stages of the disease. After the destructive process has reached the deeper parts, such as the submucous connective tissue, perichondrium, or even the cartilages themselves, necrosis of the cricoid, arytenoid, or thyroid cartilage may be present. The ulceration in such an event is irregularly serpentine, deep, and extensive, with borders surrounded by granulations and scar-tissue, while the floors consist of sloughing dark-gray or greenish masses, more or less bathed with pus and sputum. The intervening mucous membrane is thickened and irregular in contour, of dark color, and in patches consists of little more than granulation-tissue.

There are, of course, gradations between these types of local disease, which give varying and sometimes quite anomalous pictures. For instance, the hyperemia, swelling, or ulceration may be limited to just one arytenoid body, or one aryepiglottic fold, or one side of the epiglottis; or the infection may be almost confined to one side of the larynx, especially when the process first takes place in the deeper tissues; while in other cases there may be the appearance of considerable inflammation or hyperemia of one part, with an anemic infiltrated appearance of another part. There are also great variations in the distribution of the ulcerations. They may be confined to the laryngeal surface of the epiglottis or its very edge; or the posterior wall may be the seat of undetected ulcerations. It is therefore advisable in many cases to resort to Killian's method of examining this wall (see page 872) in order to ascertain its condition. There may be only two or three ulcers visible, and those situated on the vocal bands only; or, on the other hand, small ulcers may be scattered over the epiglottis, ventricular bands, arytenoid bodies, or vocal bands respectively, as if sprinkled into the vestibule of the larynx. Necrosis and ulceration of the tissues will surely take place more or less extensively in the natural course of events. But either under appropriate treatment or spontaneously, in the cases of slower march, a retrogression and healing of ulceration may occur. When this event transpires, granulation and cicatrization with their attendant contraction will mark the retrogression of the disease. The cicatricial tissue is not nearly so abundant as in syphilis or

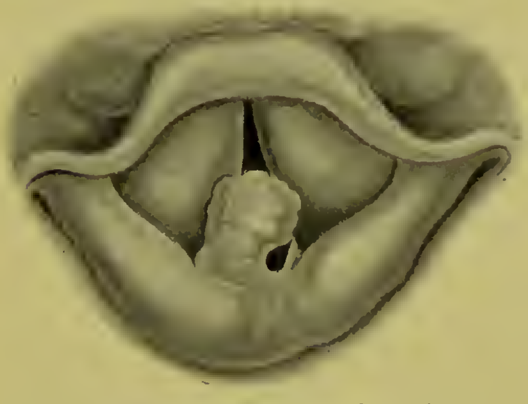

FIG. 616.—Tuberculous tumor-formation on the posterior wall with pale rigid infiltration of the ventricular bands and edematous swelling of the arytenoids (Grünwald).

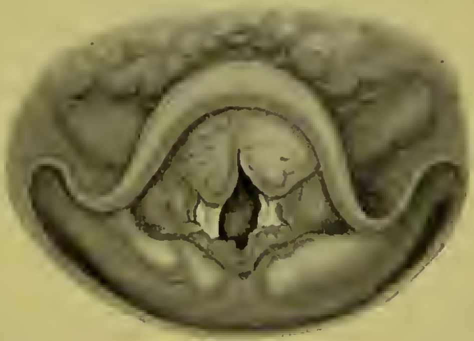

FIG. 617.—Hard raspberry masses of tuberculous infiltration without ulceration, almost filling the larynx (Grünwald).

lupus, because the patient does not usually live long enough to recover from extensive destruction of the tissues in tuberculosis. Yet there may be enough found to cause at least uncomfortable if not dangerous interference with respiration from stenosis or enough to produce troublesome aphonia. The vegetative proliferations also may become threatening, requiring removal, for sometimes they amount to tumors of considerable size (Figs. 616, 617). These vegetations are sometimes ejected spontaneously (J. Solis-Cohen). Again, the function of the larynx may be compromised by hypertrophied (reparative) tissue (superior and inferior hypertrophy) organized in folds or ridges (as seen in Fig. 618), or the action of the vocal bands may be impaired by adhesions. When ulceration begins the parts are usually freely bathed with muco-pus, which is more or less adherent to the roughened surfaces, and shows usually in the image as partially desiccated or coagulated clumps, or as stringy bands or threads. The interarytenoid space is nearly always so covered; while the posterior wall of the larynx, as well as the walls of the trachea, may be plastered with clumps of sputum.

Diagnosis.—Laryngeal tuberculosis is often difficult to differentiate from chronic laryngeal catarrh, syphilis, lupus, and sometimes certain forms of epithelioma; and, as Schech says, may baffle differentiation in some instances. When a clear and satisfactory history of the patient can be obtained, the difficulties are very much lessened, if not removed. There are numerous instances on record of a mixture of these diseases taking place; as, for instance, syphilis becoming implanted upon a subject suffering from laryngeal tuberculosis (see Fig. 622), in which case the difficulty of diagnosis is great. It is often confounded with ordinary hypertrophy of the laryngeal mucous membrane accompanying chronic catarrhal laryngitis or syphilitic laryngitis. Syphilis of the larynx, however, is usually preceded not only by its own peculiar clinical history, but by the occurrence of the local disease somewhere in the upper structures of the throat, such as the soft palate, pharynx, tonsils, or the nasal septum. This is especially true of the tertiary form, which shows preferably in the soft palate; whereas the lesions of laryngeal tuberculosis usually begin and remain in the larynx: but in the advanced stages the local appearance of this affection frequently simulates tertiary syphilis, lupus, or epithelioma. In secondary syphilis the ulcers are of a somewhat different character—being deeper, kidney-shaped, or irregular, with sharp-cut, everted edges, but they may be situated, as in laryngeal phthisis, on the epiglottis or aryepiglottic folds, vocal or ventricular bands. The tumefaction of the surrounding tissues is generally much less than in tuberculosis, and the inflammatory areola about the ulceration is usually present and characteristic. The parts are generally less painful than in laryngeal tuberculosis. In tuberculosis the ulcers are commonly shallow, of lenticular shape, with smoother edges, and with less disposition to immediate sloughing than syphilis. Syphilitic ulceration is attended with less tumefaction, and is in preference located on the epiglottis or vocal cords; whereas tubercular ulceration usually appears first in the region of the arytenoid cartilages or interarytenoid space, and is attended with tumefaction.[1] The grayish or yellowish tubercular spots sometimes described by authors as visible just beneath the surface of the mucous membrane (miliary deposits) are very rarely observed, although sometimes a mottled appearance does accompany the early stages of tubercular infiltration. In lupus, while the nodular growth is not as plain as if occurring on the skin (see Lupus, page

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[1] The rough rule, "anterior lesions are syphilitic; posterior, tuberculous," often holds good.

1060), yet the papillomatous or granular appearance is well enough marked. Its course is very slow, and after softening has taken place the ulcerations soon coalesce to form a few discrete plaques, the everted, red, granular, ragged or papular edges of which are characteristic. Outside of these spots may be seen zones of thickened papillomatous membrane of varying hues of red. Besides, the parts are not painful to the touch, nor is there much pain in swallowing. Pyrexia is usually absent, and during remission the cicatricial tissue is prominently visible. In the so-called secondary form of tubercular laryngitis (Fig. 618), the peculiar paleness of the mucous membrane, with characteristic swelling of the arytenoid bodies, known as the "clubbed appearance," will serve, when present, to settle the diagnosis at once, even without the presence of pulmonary symptoms.

Epithelioma usually invades the larynx from the lateral wall of the pharynx, the tongue, or the esophagus, very rarely occurring as a primary affection in the larynx unless preceded by some benign neoplasm or lupus. It is of slow growth and without much constitutional disturbance. When it does occur in the larynx it is usually in the deeper regions of the organ, and will be found as a mass of tissue raised above the surface of the mucous membrane. It will be of a very deep-red color, of velvety contour, with fissured and sinuous channels bordered or filled by sloughs coursing through the mass here and there. It presents no definitely bordered ulceration, but irregular pockets, and readily bleeds upon being touched. It conveys the idea of an excrescence from the first. The cervical glands are usually very early enlarged and hard. Sarcomatous tumors of the larynx are more rare than the myxo-sarcomatous. Their growth is rapid and presents the smooth appearance and contour of a vascular tumor or polyp. The growth is prone to bleed upon the slightest provocation, and does not present a lobulated appearance nor any of the characteristic ulcerative details of either syphilis or laryngeal tuberculosis. It appears as if independent of the surrounding tissues—not blended with them. Besides, there are no constitutional signs presented, at least for a time, if we except the cachexia.

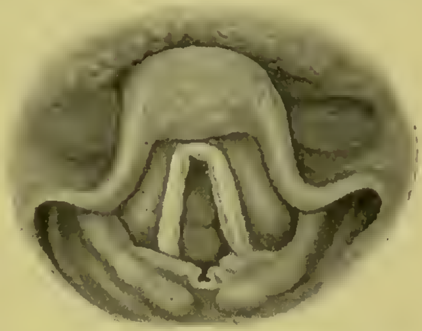

FIG. 618.—Nodular, lupus-like infiltration of the epiglottis, true and false cords, forming small tumor-masses on the arytenoids, and causing total aphonia (Grünwald).

Glanders and leprosy sometimes simulate, in their local manifestations and appearance, laryngeal tuberculosis; but the history of the case and the preceding lesions of the skin or lymphatic glands in leprosy, and of the nose or mouth in glanders, will serve to distinguish these affections from each other. In the advanced stages, when the destruction of tissue has been considerable and perichondritis or cicatrization has been concomitant, it is often very difficult, from appearances alone, to distinguish syphilis or lupus from laryngeal tuberculosis; especially is this true of the former affection. Yet, generally by an exploration of the chest, taken together with the clinical history of the case, one may clear up all doubt.

Prognosis and Course.—The prognosis is always grave. The form described as acute tuberculous laryngitis, or inflammatory tuberculous laryngitis (tubercular infiltration), offers practically no hope, because it is merely a local manifestation of a general miliary tuberculosis which may possibly be affecting any or all of the glandular organs of the body. This form of general infection sometimes attacks persons in apparently robust health, whom one would think from their appearance would be able to resist, for a time at least, any sort of general infection or sepsis. In such persons, however, its course may be, and indeed usually is, as rapid as with those appearing more delicate. The larynx soon presents evidences of great inflammation, and its tissues soon break down. We meet with cases, however, which might properly be classified as acute, in which the disease becomes limited and retrogresses for a time, even though there may be well-marked physical signs of involvement of the lungs. I have met with several such cases which, contrary to expectation, have remained passive for a long time. In the more chronic forms, manifested by pale, anemic mucous membranes, the disease usually runs a slower course, but is almost always fatal. These cases are frequently accompanied by systemic infection of the bronchial lymph-nodes or spleen. Such cases may run an inactive course, however, usually unaccompanied by either the intense odonphagia or dysphonia of other forms; yet the voice is nearly always more or less impaired. The limited forms of the disease usually respond to appropriate treatment and regimen, and, excepting for exacerbations of acute laryngitis—the result of attacks of influenza, etc.—may be kept more or less passive for years, if not permanently checked.

Treatment.—The treatment of this affection is generally classified as general and local. The general treatment may be considered as *climatic, hygienic, specific,* and *symptomatic;* and the *local* treatment may be discussed under the following captions—local medication by inhalation, sprays, or insufflations, and surgical treatment.

The influence of climate in modifying all of the tuberculous diseases is well known and need not be discussed at length. However, in no form of phthisis is it more disappointing than in that of *active* laryngeal tuberculosis. Usually a warm moist climate is the most beneficial to the majority of cases, provided it is not too enervating, such as a tropical or subtropical one. The dry warm climates, such as those of Arizona, New Mexico, and some parts of California, do not seem to suit many of these cases, perhaps on account of the dryness of the air, for in many instances the laryngeal symptoms seem to grow worse after entering such localities. When a dusty or windy feature is characteristic of the climate of the locality, the discomfort and distress is sure to be increased (Ingalls). With regard to altitude, it may be pointed out as a rule that only a moderate elevation is well tolerated by many subjects. A large majority of those who dwell above 3000 feet are apt to suffer extra distress, if not exacerbations of inflammation of the larynx; this is especially true of the well-marked inflammatory cases. There are, however, many exceptions, especially when the local lesion is in a primitive state, or when much infiltration or ulceration is present. Strange as it may seem, cases showing but little involvement of the lung are not as much relieved as those in which there is notable involvement of the lungs, such as commencing softening or excavation. A cold dry climate with plenty of sunshine has been found even more generally beneficial than a highly-elevated dry or dusty one. Sometimes, however, when the cold is very intense, the laryngeal mucous membrane seems to be irritated thereby, especially if there be much hyperemia. In short, according to experience, a windy, dusty locality is not suitable for cases of laryngeal phthisis, except when there is more or less ulceration of the larynx or caseation of the lungs going on. A moist warm climate or ocean-voyages would therefore seem preferable as a rule. Of course, it will be understood that the individual and the individual circumstances may furnish valid exceptions to any rule.

The hygienic treatment consists for the most part in proper clothing, not too frequent bathing, and the administration of nourishing but digestible food; out-door life as far as possible during the day, with a cool (but not too cold) sleeping-apartment. Patients with this disease should be very careful about exposure to coal-gas for any length of time. The use of tobacco, either chewing or smoking, ought to be prohibited, also the too frequent use of cold and hot drinks in close alternation, such as ice-water and hot tea or coffee at meal-times. The full quota of sleep each twenty-four hours should be obtained. Patients should be enjoined to spare the voice as much as possible in conversation; singing and public speaking ought to be prohibited. I have known several instances where patients in the early stages of laryngeal phthisis, presenting certainly good prospects for at least temporary recovery, have been thrown into almost a fatal exacerbation by the strenuous use of the voice. One of these cases, I may briefly state, was that of a clergyman who was making an apparently good recovery. He had been away for some months from his duties and had returned to his residence in a district containing a great many friends among the congregations of several churches where he was well known. About the time of his return there was considerable church activity and public agitation on special moral questions concerning the district in question. As he had been a popular and efficient pulpit-orator, lecturer, and worker, he was persuaded to take an active part in these events. After making three prolonged and rather vehement orations in three adjacent towns during a period of a week or so, he contracted a violent inflammation of the larynx, which renewed the exudation into the tissues, and ulceration—affecting permanently the integrity of the larynx and necessitating his immediate removal to the South, where he expired in about nine months. A similar effect occurred in the case of a prominent lawyer who was a patient of mine and whose case bade fair to end in recovery. He was induced to return from a needed sojourn in the West Indies (where he was sent) to take part in some important cases that he had been engaged for, and after finishing this task a severe inflammation of the larynx with extreme tubercular infiltration followed. Many other like instances could be given to show the necessity of rest—as absolute as may be—in the management of laryngeal phthisis.

The specific treatment of laryngeal tuberculosis has not yet arrived at the perfection which we would wish. A great many agents have been brought forward from time to time which have undoubtedly been attended by a modicum of good results; but owing to numerous failures they have been gradually put aside. The seekers of truth in this field of discovery are numerous, however, and we may with reason hope that—guided by past failures and partial successes—the right series of therapeutic measures may yet be reached. Among the more modern agents of supposed specific value may be mentioned creosote, guaiacum, tuberculin and its various modifications, dog-serum, horse-serum—plain and tuberculized—nuclein, chlorid of gold and sodium, cantharidid of potassium, chlorin water with chlorid of sodium, oil of cloves, cinnamon and other essential oils, chlorid of zinc, the formates, iodin, etc. There are many cases on record of moderate and even brilliant results following the use of each of these agents, both in laryngeal and pulmonary tuberculosis; but, as said above, the effects have been short of general utility. I am led to the conviction, from my own experience with these several agents, that they are perhaps less useful in a specific sense in laryngeal tuberculosis than in pulmonary tuberculosis. These agents have all been used in the general belief, of course, that all cases of laryngeal tuberculosis were simply the expression of a general infection. But undoubtedly some of the cases reported to have been cured have been aggravated forms of ordinary chronic inflammation of the larynx; while some may have been cases of chronic laryngitis complicated by syphilis. I have myself been deluded once in a while by such erroneous diagnoses, and undoubtedly others have met with the same misfortune. These remedies have been used both hypodermatically and *per os.* While the hypodermatic use of such remedial agents is manifestly more desirable, the attendant pain and difficulty of properly carrying out this plan of medication render its general adoption of doubtful practicability, especially in private practice.

I am still of the opinion that among these agents *iodin, when conjoined with some proteid substance,* furnishes the best results so far as specific medication is concerned. It seems to make some difference in the ulterior effects whether the drug is administered in connection with iodid of potassium, glycerin, and water, without some *proteid* material or not, for I have found repeatedly in the same patient that the administration of the drug, either hypodermatically or by the mouth, in a mixture with *sterilized bouillon* will produce more lasting benefit than when given otherwise; so that we have adopted the habit in hospital practice of administering it in bouillon or milk. It may also be given advantageously in combination with glycerin and extract of malt. I have also used creosote and guaiacol in the same way with apparently better effects than when given alone; and we may therefore be pardoned for the suggestion that perhaps the majority of remedies administered for constitutional effects—if there are no chemical contra-indications—would be more efficacious when so combined. Whether a chemical combination actually takes place between these agents and some unknown proteid of the animal fluid used, I am unable to say; but possibly at some future time this point may be satisfactorily demonstrated. Guaiacol and oil of cloves are both very useful when administered in an emulsion, in suitable doses, three or four times daily, or (sometimes a better way) in very small doses repeated every hour for a certain number of times, according to the tolerance of the patient. The former agent as "benzosol" has given very good results. In the more chronic cases characterized by anemia of the mucous membrane, phosphorus administered in solution with olive oil in capsule is highly beneficial. This combination may be found on the market in the form of capsules containing from one one-hundredth to one-thirtieth of a grain of phosphorus in 10 or 15 minims of oil. It should be administered always just after food has been taken, and if irritation of the stomach, urticarious eruption, or aphrodisiac effects follow its use, the dose must be materially modified or the administration of the drug stopped. Arsenic, especially the arsenate of iron, chlorid of gold and sodium, salicin, and strychnin are very valuable tonic agents. Strychnin and salicin are among the most useful agents for general effects. When there is much hyperpyrexia, salol or sodium salicylate may be substituted for salicin. For the temporary repression of temperature, acetanilid, or aconite, or judicious bathing may be resorted to. The somewhat prevalent practice of combining either of these agents with other things—sometimes not synergistic—is certainly a bad one! Of course, this criticism does not apply to mixtures containing sedatives, such as codein or hyoscyamus. But, as a rule, it is preferable to administer all drugs designed for temporary effect, *alone.* The use of alcoholic beverages in this disease is fraught with perplexity: for while in many instances alcohol in one form or another is indicated, yet the condition of the

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throat may be such as to prohibit it, either on account of the local pain attending its deglutition, or on account of its decided and directly deleterious effects upon the diseased larynx. It will be found better generally to select the malt beverages and preparations, rather than the spirituous. The administration of a little rectified spirit with milk, however, will be found useful when large draughts of whiskey, brandy, rum, etc., cannot be consumed without distress or evil effects.

The *symptomatic* treatment of laryngeal tuberculosis can scarcely be formulated, and will depend upon a variety of circumstances which will indicate the agents to be selected for each individual case in order to allay cough, pain, hyperpyrexia, diarrhea, mental perturbation, etc. As laryngeal tuberculosis when advanced is perhaps one of the most painful affections to which flesh is heir, the practitioner may be sorely taxed to meet the constant demand for relief without incurring other mischief. However, opium and its salts, for internal medication in such cases, still retain their popularity—codein, morphin, or the powdered drug seems best. Cough may be mitigated by the milder anodynes, such as codein, tincture of opium, hydrochlorate of cocain, hydrate of chloral, etc., together with the various expectorants and balsams (see Formulary). Care should be taken that syrups are not used too freely, lest nausea, vomiting, and anorexia be favored. Chlorid of ammonia and other chlorids may cause severe pain when the mucous membrane is ulcerated, otherwise they may be used. Sleep may be secured by the administration of sulfonal, trional, chloral, the bromids, or some preparation of opium, alone or in combination with one of the other anodynes mentioned.

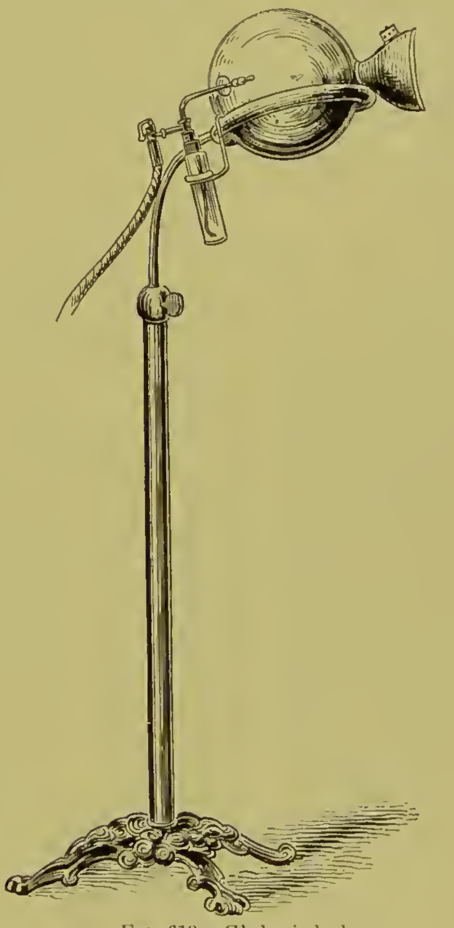
Fig. 619.—Globe inhaler.

The *local* treatment consists of inhalations of gases or medicated air, sprays, and powders. Inhalations of medicated air are of little permanent benefit excepting in the early stages, or when there is an unusual amount of salivary or other expectoration. There are a number of suitable inhalers in the market, from which volatile substances may be inhaled either with or without the aid of hot water. A simple instrument may be made of tin, with a perforated receptacle at its distal end for containing a piece of sponge, upon which may be dropped preparations of creosote, carbolic acid, menthol, camphor, creolin, tinct. benzoin, tinct. myrrh, etc., combined with chloroform, ether, alcohol, or spirits of ammonia. These agents may also be dropped into hot water contained in a hot-water inhaler. These instruments can be used by the patient several times a day, with sometimes very good effect in the early stages of disease. When, however, this form of inhalation increases the sensation of "dryness," "stiffness," or pain referred to the throat, they should be discontinued. A preferable method of inhalation in general is accomplished by spraying the medicament into the throat from either a steam or a hand-ball atomizer. The spray may be projected directly into the throat, or it may be projected (especially if it be oleaginous) into a globe inhaler (see Fig. 619), from which it can then be inhaled through a face-shield which will completely enclose the nose and mouth. This is a much more thorough method of local treatment in laryngeal phthisis, especially when the agent is in the form of an oleaginous solution. All such agents as creosote, camphor, menthol, carbolic acid, guaiacol, creolin, phenol, oil of eucalyptus, etc. may be dissolved in a pure fluid petrolatum or olive oil and projected into the inhaler, whence they can be carried into the larynx by the ordinary process of respiration. Although this means of local medication may fail in many instances of producing radical change, it, nevertheless, affords a very practical and efficient method of relief. The watery solutions are best used by spraying directly, as near as possible, upon the parts. In this manner there may be used with tolerable efficiency solutions of formate of soda, biborate of soda, alum, boric acid, carbolic acid, cocain, morphin, hydrochlorate of coniin, tannic acid, sulphate of iron, sulphate of zinc, nitrate of silver, chlorid of zinc, etc. These chemicals may be used in varying quantities according to the requirements of the case (see Formulary). *Insufflations* of powders upon the larynx, although of great value, especially when ulceration has taken place, are sometimes not well tolerated on account of the desiccation of the secretions or the prolonged and distressing paroxysms of cough which they produce. Among the agents most useful as insufflations in laryngeal tuberculosis may be mentioned iodoform, iodoform with boric acid or bismuth, naphthalin, aristol, europhin, boric acid, tannic acid, ammon. citrate of iron and potassium, stearate of zinc or alum, subnitrate or tannate of bismuth, morphin with gum acacia, etc. The insufflations should always be preceded by a thorough spraying of the parts with some detergent solution, such as biborate of soda or phosphate of soda; and care should be taken that the amount of powder propelled upon the larynx is not too great, otherwise distressing spasm and cough may supervene, lasting a considerable length of time and producing not only extra congestion and irritation of the parts, but, perhaps, vomiting and exhaustion. It is often desirable to apply directly with a brush or pledget of cotton certain medicaments, in the form of pigments, to ulcerations. This may be done preferably by using the Wagner laryngeal brush or a pledget of absorbent cotton, either held by forceps or wound around the roughened end of a probe or applicator. In this way strong solutions of nitrate of silver, chloracetic acid, lactic acid, carbolic acid, chlorid of iron, chlorid of zinc, formaldehyd, creosote, formate of sodium, etc., may be carried to the part.

The range of surgical measures for the relief of this disease is necessarily limited. The papillomatous excrescences which sometimes accompany progressive ulceration may have to be removed by evulsion, snaring, or escharotics. Especially is this the case when such protuberances occur about the vocal cords or ventricular bands, and by their presence obstruct respiration or produce great mechanical irritation of contiguous parts. A few years ago Dr. Heryng adopted and promulgated the plan of thoroughly curetting tuberculous ulcers and afterward applying to the surface so abraded lactic acid in the proportion of 20, 30, or 50 per cent. solutions, or stronger, according to effects. This met with considerable favor for the treatment of some cases. There is no doubt that it may be a very efficient and practicable measure in cases of isolated ulcerations in the upper part of the larynx; but for a large proportion of cases of laryngeal tuberculosis presenting no limited lesions, but a simultaneous breaking down of many spots separated from each other, this plan of treatment will necessarily be limited in its application. Besides this, many times the lesions will be found out of reach. Then, too, there are individuals in whom, for some reason, these parts are too physically sensitive for interference of that sort, even under the influence of cocain, without exciting a general disturbance which is not easily allayed. This was my experience in two favorable cases, when I was obliged to desist after early manipulation. The application of lactic acid without the curettement is generally well borne and efficient. Scarification of the larynx in the chronic form is a measure of relief which is not practised, perhaps, as often as it ought to be. The writer called attention to this plan of relieving the tension of the parts some twelve years ago; and many practitioners who have adopted the plan have reported good results from it. It ought not, however, to be indiscriminately adopted, because the objection urged against the practice, that it opened up the deeper tissues to probably further infection, holds good in many instances. However, as ulceration in any event is inevitable, especially after great infiltration, it will be found that the anticipation of nature's step in this direction by scarification will greatly modify the subsequent necrosis of the tissues, and at the same time enable the practitioner to meet the prospective condition by more thorough medication. I would therefore still advise in some cases of inordinate effusion—even though it be not considered edematous—a reasonable amount of scarification over the tumefied parts, whether it be the arytenoid cartilages, interarytenoid space, ary-epiglottic folds, or epiglottis.

Hypodermatic injections of creosote or other agents into the laryngeal mucous membrane have been in my hands very disappointing.

It must be confessed that local treatment in many cases is of little value, excepting for the palliation of pain and other phases of distress, mainly, perhaps, because the lesions are more or less out of reach and too deep in the mucous membrane. On the other hand, in some of the slower-going cases, characterized by limitation and accessibility of the lesion, a judicious local treatment constitutes our principal means of assisting nature to resist the progress of the disease. We must agree with Gleitsman that, theoretically, the thorough removal by surgical means of the diseased tissues and the induction of a healthy reparative process is the ideal desideratum; but, unfortunately, there are as yet no practical ways of successfully carrying out such laudable aims. So we are still, as it were, obliged to drift along empirically, without any exact principles of therapy to follow in the management of this disease. It will, therefore, be impossible to lay down any rules for the application of this, that, or the other agent or preparation; and the question of the selection of topical medication must be left to the skill and experience of the practitioner. It may be added, however, in conclusion, that of all agents for general use, perhaps none surpasses iodoform, aristol, resorcin, tannogen, or mercury protochlorid, used either by insufflation or in solution or in mixture with petrolatum oil. Next in value, especially when ulceration has begun, may be ranked lactic, chloracetic, and carbolic acids; and after these, chlorin water, sodium formate, silver nitrate, zinc chlorid, mercury bichlorid and biniodid, creosote, and oil of eucalyptus. The inhalation from a face-shield inhaler of 1 ounce of solution of mercuric chlorid (1 : 3000), immediately followed by an inhalation of from 2 to 4 ounces of a solution of (1 to 2 per cent.) iodoform in petrolatum oil, will oftentimes prove highly beneficial to a large number of cases. The inhalation of chlorin water combined with a solution of salt in water is also very efficient when it does not cause much pain or coughing. Usually from $\frac{1}{2}$ to 1 ounce of each (mixed) is as much as ought to be given at a séance.

One of the leading therapeutic indications is toward the assuagement of pain and laryngeal distress. For such purposes we must resort preferably to the local application of either cocain, coniin hydrochlorate, bromoform, morphin formanilid, atropin, aconitin, chloroform, menthol, ethyl-bromid, creolin, or similar agents. These substances are best used in the form of spray or pigment, excepting ethyl-bromid and chloroform, which are volatile (see Formulary).

In cases where much soreness is generated from a more or less continued muscular action of the pharyngo-laryngeal muscles, coniin hydrochlorate, menthol, or ice (held in the mouth until melted) will be found beneficial. For promoting an antagonistic effect against the burning and rawness often complained of, either aconitin, atropin, or hyoscin will be found useful in addition to other treatment.

Cocain hydrochlorate or morphin alone, or in combination with either iodoform, aristol, naphthalin, or carbolic acid, will be found to be the "sheet anchors" for the relief of pain. The frequent cleansing of the throat with sprays containing peroxid of hydrogen, boric or carbolic acid, when well borne, is a good practice and one which greatly promotes the comfort of the patient, to say the least. The formulæ for the use of these several agents are appended.

FORMULARY.

Sprays.—
(1) Zinc chlorid, 1–3%; (2) Zinc sulphate, 1–4%; (3) Mercuric biniodid, 0.2%, and Potassium iodid, 4%—in glycerin and water.
(4) Sodium formate, 2–3%; (5) Coniin hydrochlorate, 0.2%; (6) Mercuric bichlorid, 0.2%, and Hydrogen dioxid, 16%—in water.
(7) Alumnol, 2%, and Cocain hydrochlorate, 1%—in peppermint-water.
(8) Oil of eucalyptus, 3%; (9) Menthol, 1%, and Camphor, 1%; (10) Creolin, 1.5%, and Alcohol, 0.2–0.5%—in liquid petrolatum.

Pigments.—
(11) Iodin, 0.4%, and Potassium iodid, 1%; (12) Formaldehyd, 10%; (13) Pyoktanin (blue), 2%, and Acacia, 2%—in water.
(14) Hyoscin hydrobromate, 2%; (15) Aconitin, 0.2%; (16) Morphin sulphate, 1%, and Antifebrin, 2%—in glycerin and water.
(17) Lactic acid, 20–40%, in water. (18) Carbolic acid, 12.5%, in glycerin.

Insufflations.—
(19) Tannic acid, 6%; Powdered starch, 19%; and Bismuth subnitrate, 75%. (20) Resorcin, 50%, and Powdered starch, 50%.
(21) Aristol, 50%, and Powdered starch, 50%. (22) Silver nitrate, 1–2%, and Talc powder, 98–99%. (23) Tannic acid, 3%; Cannabin tannate, 7%; Bismuth subnitrate, 45%; and Powdered starch, 45%. (24) Silver nitrate, 3%; Acacia powder, 32%; and Bismuth subnitrate, 65%. (25) Armenian bole, 25%. Sugar, 25%; and Sodium biborate, 50%. (26) Morphin sulphate, 0.3%; Mild mercuric chlorid, 20%; Sugar, 40%; and Bismuth subnitrate, 40%; (27) Morphin sulphate, 3%, and Iodoform, 97%. (28) Iodoform, 11%; Boric acid, 34%; Naphtalin, 55%; and Oil of Bergamot, a sufficient quantity.

Internal Medication.—
(29) Compound solution of Iodin (Lugol's solution), 15 cc., and Glycerin, 15 cc. Ten drops in milk every four hours.
(30) Syrup of ferrous iodid, 30 cc., and Compound syrup of the hypophosphites, 30 cc.
Tablespoonful three times a day.
(31) Salicin, 4 gm.; Calcium hypophosphite, 6 gm.; Whiskey, 150 cc.; and Fluid extract of Malt, 210 cc. Two to four teaspoonfuls three times a day.
(32) Sodium salicylate, 412 gm.; Cinnamon-water, 120 cc.; and Water, 120 cc. Two teaspoonfuls three times a day.
(33) Powdered bone, 8–12 gm.; Glycerin, 30 cc.; and Cinnamon-water, 90 cc. Teaspoonful three times a day.

TUBERCULOSIS OF THE NASAL PASSAGES AND THE PHARYNX.

The Nasal Passages.—Tuberculosis confined to the nasal passages exclusively or primarily occurring there is extremely rare (Cohen, Bosworth, Chiari, Hajek, Risdel, Kafeman, Schäffer). The disease is more often observed in connection with pulmonary phthisis of an advanced stage, or, according to Kafeman, in cases of latent tuberculosis. This author states that the reported cases of primary tuberculosis of the nose, pharynx, or larynx, without pre-existing tuberculosis or latent foci elsewhere, should be received with a great deal of skepticism. Authoritative statistics derived from autopsies are cited in support of this statement.

The more common site for the development of the disease is in the region of the cartilaginous septum of the nose, although Chiari observed that in his six cases other parts as well as the septum were affected; in one the maxillary sinus being involved. Kaschier distinguishes a form of the disease which particularly affects the bony framework. Lermoyez cites cases of the occurrence of tuberculous vegetations at the vault of the pharynx. There are a few cases on record in which tuberculosis of the naso-pharynx seemed to follow operations for the removal of adenoid vegetations in patients who were previously free from either tubercular disease or hereditary tendency. A few such cases have been reported by Kafeman and others, one or two of which were followed by tubercular meningitis. It is sought to account for the occurrence of this latter class of cases upon the supposition that the wound of the operation offered an opportunity for the entrance of tubercle-bacilli, carried there either by inspired air, food, the instruments or finger of the operator. Some writers believe that in all such cases either the bacilli or some tubercular formation is already present in the glandular tissue. I have never observed a case of primary nasal tuberculosis, although having seen several cases occurring in the course of advanced pulmonary phthisis. Cases have been reported in which the disease began in the form of a few papilloma-like prolongations from the mucous membrane at intervals along the septum—tubercular tumors, as it were. These cases are notable for their slow march. The lesions oftener occur just at the vestibule of the nose.

Etiology.—The majority of observers believe that the only cause of the disease in this situation, as elsewhere, is the implantation of tubercle-bacilli, and that these micro-organisms may be conveyed to the part either from without by contact of sputum during acts of coughing or vomiting; by means of the finger, as in picking the nose; by the inspiration of bacilli-laden air; or from within through conveyance from some remote focus by either the blood or lymph (Kafeman, Chiari). The well-known ubiquity of the tubercle-bacillus and the frequency of catarrhal affections of the nose entailing abrasions, etc., are relied upon in explanation of these modes of origin. Chiari believes that the infection generally takes place by the inoculation of some abrasion or fissure of the epithelium with tubercle-bacilli conveyed there by the finger. Although adopting the idea of primal bacillary infection, he nevertheless states that he found tubercle-bacilli in four only of his six cases. Kafeman, who published two interesting cases of so-called primary nasal tuberculosis, and who likewise believes in the bacillary origin of all tubercular disease, found no tubercle-bacilli in either of his cases, but in one of them some stray specimens of the Langhans bacillus. This author attributes the malady in his cases to a probable infection through abrasions of the mucous membrane by bacilli-laden air, as neither of his subjects were tubercular nor of a tubercular tendency. The signal immunity of the nasal passages from tuberculous disease, when so constantly exposed to abrasion and invasion by tubercle-bacilli, has been a subject of much perplexing speculation. Lately, however, experimental researches of the bacteriology of the nasal passages have led to some conclusions which may account for the hitherto-observed immunity mentioned. Clausen found that the nasal passages of rabbits were apt to contain quantities of pyogenic bacteria. Von Besser, Fernier, Lermoyez, and others found that the human nasal passages, pharynx, and larynx contained numerous bacteria, such as the diplococcus pneumoniæ, streptococcus pyogenes aureus, tubercle-bacillus, etc.; while St. Clair Thomson, Hewitt, and others found that healthy nasal passages were bacteria-free. Fernier and Bretschreiber also, making similar investigations with varying results, concluded that the nasal passages were only quasi-aseptic. The conclusions of Thomsen and Hewitt were to the effect that the normal secretions of the nasal passages and throat were bactericidal, and hence neutralized immediately the virulence of any superimposed micro-organisms. From all these observations, and from the negative results of clinical experience, it is fair to infer that perhaps some of these cases of so-called primary nasal tuberculosis were really of doubtful character. Those observers (Störck, Thost, Heryng) who really believe that fissures or abrasions of the mucous membrane invite the origin and development of the disease, confess that there must be some particular change in the cell-life of the part in order to consummate the establishment of the malady. Strauss has found that the nasal passages and pharynx of healthy persons who spend much time in the presence of phthisical patients, or in rooms where phthisical patients are confined, contain large numbers of tubercle-bacilli. The question as to the power of tubercle-bacilli to penetrate sound epithelial tissue is yet an unsettled one. A further discussion on the etiology of this subject will be found in the section on Tuberculous Laryngitis.

Symptomatology.—The early symptoms consist, for the most part, of a mild coryza and frequent attempts at sneezing, with a sensation of fulness and uneasiness within the nasal passages. The discharge, which is at first of a mucous character, gradually becomes more serous or muco-purulent, but is not apt to be very profuse. After a while the nasal passages become more or less plugged with exfoliating crusts, which accumulate just inside of the nostril and cause considerable itching, burning, and other irritation. There is rarely much odor to the discharge, such as we meet with in ozena. There may be slight swelling of the skin of the nose, redness and marked soreness. Very little pain is complained of, however, unless the internal parts be touched. The disease is usually confined to the mucous membrane covering the cartilaginous septum, although after a time ulceration of the turbinals may be observed. The ulcerations are usually small, with red rims, and discrete, although in places there may be confluence of them, and they are not disposed to heal. Slow-growing perforation of the cartilaginous septum is sure to take place, and in some cases this may be the first symptom to excite the alarm of the patient. The perforation gradually extends, by a molecular dissolution of the edges, until nearly the whole of the triangular cartilage disappears. When the disease takes an exacerbation, as sometimes occurs, its extension may become quite rapid, covering more or less of the whole line of the septum and even extending to the pharynx. The local symptoms in this event are, of course, very much aggravated. In all cases pain, coryza, and lachrymation may make the patient very miserable, aside from more or less constitutional disturbance. If the lungs or other organs are also the seat of the tubercular process, the constitutional symptoms of septicemia are very much aggravated. Tubercular meningitis is to be expected as a termination of cases of true nasal tuberculosis. In the form of the disease characterized by tuberculous tumors, the surrounding tissues are slow to take on reactionary disturbance, for the ulceration is slow and confined to the little neoplastic formations. It has been observed, also, that the general disturbance is much less in these cases, and that the cartilaginous structures escape destruction for a longer time. Perichondritis and periostitis, with necrosis, may be expected, however, in severe or neglected cases; but, as a rule, except for the destruction of the septal cartilage, the ulceration usually confines its ravages to the mucous membrane.

The Pharynx.—Primary tuberculosis of the pharyngeal mucous membrane is very rare, but does occur, and may be tolerably latent for a time. It is frequently more or less mixed with syphilitic disease or laryngeal phthisis, and often coexists with these affections or carcinoma (Baumgarten, M. Schmidt). In my own practice I have never met with an instance which was not connected with either a syphilitic taint or with laryngeal or pulmonary phthisis. Two notable examples which came under my observation were preceded in the one case by secondary, and in the other by tertiary, syphilis. Kafeman states that there are two forms of pharyngeal tuberculosis, one a miliary, and the other a papular or tumor, form. Cases of the former class are characterized by the development in many places of small miliary tubercles, and in the latter by the formation of one or two patches only—generally upon the lateral walls and posterior surface of the velum palati. The nasopharynx does not seem to participate very often in the disease, but the base and tip of the tongue and the oral cavity are more likely to do so. The ulcers are small, surrounded by a narrow red, raised rim. As the disease advances they may coalesce and excavate more or less beneath the edges of the mucous membrane, giving the edges a raised, worm-eaten, or irregular appearance later on. In some cases considerable infiltration takes place, so that the mucous membrane in the neighborhood or all over the pharynx (if it be the miliary form) appears edematous. The pharyngeal wall suffers, and the velum palati is also very apt to participate, in which case the uvula is edematous and very tender. The shapes of the ulcerations vary, but are usually oval, more or less elongated, and covered with muco-pus, either soft or partially desiccated. When situated upon the posterior wall, which is exceptional, the surface presents a cleaner and rawer appearance. Deglutition is always very painful—the patient shrinking from swallowing very hot, very cold, or salty food. In some instances the deglutition of the saliva is very painful. In advanced cases the cervical glands are more or less swollen and tender, as are also the muscles of the neck. The patient presents an anxious expression of countenance, is pallid, and emaciates rapidly after the disease has progressed for some time, owing to the difficulty of obtaining sufficient nourishment. When the tongue is involved, the parts especially affected are the tip, sides, and base. Ulcerous cracks and fissures, more or less surrounded by small papillæ, are characteristic. The organ is always very sensitive. In these cases, even if confined to the pharyngeal cavity, the tonsils are apt to be involved. Indeed, the tonsils are said by Strassman, Denochowsky, Dieulafoy, and others to be extremely liable to tuberculous disease. The first-named observer found the tonsils tuberculous in 13 out of 21 autopsies made upon tuberculous subjects, and Denochowsky, in each of 15 autopsies of similar subjects, found the tonsils tuberculous. Dieulafoy injected parts of extirpated tuberculous tonsils into 61 animals, 13 per cent. of which contracted general tuberculosis. Cornil, on the other hand, examined 70 cases, and found giant cells in 4 only; while Virchow has declared that tonsillar tuberculosis is very rare. It is also said that the tubercular process in these glands takes place primarily in the deeper tissues—the lower endothelial lining of the follicles or crypts and lymph-spaces—and that ulceration does not readily follow. For this reason the surface indications are therefore wanting and the disease may escape notice. The conclusions of some observers seem to indicate that these glands are common seats of latent tuberculosis. Nevertheless, the theory that a very favorable lodgement for tubercle-bacilli is offered by the crypts of the tonsils, and also that the surface-manifestation of the disease may be infrequent owing to deep infection, would seem to offer to a practical mind an inadequate explanation of the infrequency of the visible manifestations of tonsillar tuberculosis. Again, why should the advent of tubercle-bacilli into the deeper structures of the tonsil through the blood-vessels and lymph-channels, instead of from without inward, be a selected mode of infection? The only explanation worthy of acceptance would be that perhaps an antitoxic character belonging to the secretions of the tonsil is sufficient to render the surface immune to the action of tubercle-bacilli—that is, supposing that the bacilli are the only cause of the tonsillar disease. It will be remembered that St. Clair Thomson and others have shown that the nasal and buccal secretions are probably strongly bactericidal; and, if this be a fact, therein may lie the explanation of the frequent escape of these glands, as well as the upper air-tract generally, from tubercular disease.

The **diagnosis** of nasal and pharyngeal tuberculosis is not always very easy. Syphilitic inflammation of the nasal septum, lupus, and sarcoma may easily be mistaken for tuberculosis. Indeed, lupus and syphilis are often much alike in their local characteristics, as well as tuberculosis and lupus. In syphilis, besides the history of the case, it will be found that the whole nasal septum is very much infiltrated, and that the disease is taking a more rapid course. When ulceration has taken place in syphilitic disease there is breaking down of larger areas, which may subsequently coalesce, although at first remaining quite distinct. The character of the ulceration is not particularly distinctive, for we may have in either disease a serpiginous, ragged, undermined sort of ulceration with raised red edges. In pure syphilitic affections of the septum, where the disease is confined to the triangular cartilage, the differential diagnosis is quite difficult in the absence of supporting clinical history. Nevertheless, a microscopical examination may serve to determine the diagnosis, although it will not be safe to rest always upon the discovery of the tubercle-bacilli alone, for these micro-organisms may be always present to a greater or less extent in the nasal secretion, even in cases which are not really tuberculous, as shown by the researches of Strauss and others. From lupus, tuberculosis may be distinguished by the much slower course of the former affection and the presence of lupous disease of the skin just external to the nose, or somewhere about the face, and the absence of any great amount of surrounding infiltration and constitutional disturbance. Then, too, the presence of the characteristic small, pointed, pinkish granulations will serve to distinguish lupus. The lupous exulceration is inclined to heal and leave its characteristic scar-tissue, while the tuberculous is not. The age of the patient also may serve to strengthen the differential diagnosis, for lupus of the nose, as a rule, attacks the young or the very old; while tuberculosis of the upper air-tract is very rare under fourteen years of age (Demme, Bollinger).

From sarcoma, tuberculosis may be distinguished in the course of the disease by the absence of a distinct tumor, which is soft to the touch, of red color, of considerable size, and showing a disposition to rapidly enlarge from its point of attachment outward. The sarcomatous growth bleeds easily. Sarcoma can only be mistaken for the so-called tubercular tumors which sometimes appear in the nose. But the latter are usually small and multiple; while sarcoma, as a rule, is confined to one or two points.

The **prognosis** of tuberculous disease of the nose or pharynx is certainly very grave, although if the disease be recognized early the prospects of the patient are not so bad, because in this situation, if there be little or no general infection, there is an opportunity of entirely eradicating the morbid process.

The **treatment** for the disease in either of these situations should be chiefly local and surgical. No time should be lost in removing, as far as possible, the diseased masses, either with the curette or the galvano-cautery, wherever they may be situated within reach. After this has been done a vigorous local treatment, consisting of the application of antiseptics, such as formaldehyd, formate of sodium, carbolic acid, resorcin, iodoform, chlorin water, or guaiacol, must be adopted. The last agent is reported by E. Fränkel and H. Bergeat to be highly useful in lupus. It is also efficient in local tuberculosis. The thorough removal of the disease, as suggested above, will be found in all cases the most efficient method of treatment. Besides local measures, great benefit will be obtained from the internal administration of iodin, chlorid of gold and sodium, arsenic, and phosphorus. Climatic changes are not as markedly beneficial as when the larynx and pulmonary organs are involved, although any regimen and hygienic measure which will promote the health of the individual will, of course, be beneficial. No attempt to repair the edges of the perforation of the septum after the disease process has become checked—by such methods as scarification, trimming of the edges, or cauterization—will prove efficient. It will be found far better to simply promote the covering of the edges of the perforation, however extensive it may be, by emollient applications.

LUPUS OF THE AIR-PASSAGES.

Lupus vulgaris, the variety with which we are mainly concerned—as is well-known—is particularly a disease of the external skin. It appears insidiously, as a rule, and slowly extending in that apparatus, terminates in a process of exulceration. It is also not infrequently met with upon the mucous membrane, which in many respects is histologically analogous to the external skin. Indeed, some observers believe that the mucous membranes are more often affected first in lupus of the face. One of the most frequent sites for the development of lupus vulgaris is at the angle of the nose, the mouth, the eye, or somewhere in the neighborhood of an external opening of the body. While some dermatologists assert that any portion of the skin is liable to its attack, others assert, upon an apparently equal basis of facts, that certain covered portions of the skin are invulnerable. It has been asserted, as a rule, that lupus vulgaris always primarily occurs upon the skin and affects the mucous membrane afterward. However the rule may be, there are instances enough on record of the primary invasion of the mucous membrane to constitute at least marked exceptions. It is stated that there are many instances of lupous disease of the lining membrane of the nasal chambers, which ran for a long time without being discovered, where no dermatic involvement ever took place. The point of origin of lupus of the nasal cavity is most frequently in the mucous membrane covering the cartilaginous septum. From this point it may gradually spread intranasally along the septum or extranasally to the vestibule of the nose and the skin. Sometimes the pharynx is involved secondarily from a focus on the nasal septum.

Etiology.—The principal etiological factor in lupus of the nose, as elsewhere, is supposed to be the tubercle-bacillus. However, as this question will be fully discussed under the caption of Lupous Laryngitis, it need not detain us here.

Symptomatology.—The objective symptoms of lupus are usually very mild, rendered so by its well-known tendency toward a chronic course. The first symptoms may be unaccountable sneezing and slight coryza, although the discharge is not apt to be profuse except in the first stages of the disease. After the histological changes incident to the first stages of the disease have become developed, the breaking down or ulceration begins to take place in small spots, and then there will be more or less formation of yellowish or brownish crusts with slight ichorous or serous discharge. The appearance of the spot is not so characteristic as when the skin is affected. In the nose the infiltration is quite insignificant, and does not present that peculiar brownish granular appearance until after ulceration has taken place. When this has happened, lines or valleys with bacon-colored bases may be seen, interrupted and surrounded here and there by little pinkish-red granules, all of which are more or less covered with scales or crusts somewhat adherent. As said before, perforation soon takes place, and gradually enlarges as the disease advances. The course of the lupous ulceration does not differ from that of other ulcerations, advancing by infiltration and subsequent breaking down, but its trail is covered by the formation of characteristic scar-tissue, which is, however, much more delicate and less characteristic here, as in other mucous membrane, than upon the skin. I have never seen a case of nasal lupus in which the adjacent skin was not involved. The destruction of the skin and consequent contraction of cicatricial tissue necessarily produce more or less deformity of the nose. Lupus vulgaris is inclined to stop before the osseous tissue, confining its ravages to the softer parts. Exceptionally, however, especially in syphilitic cases, bone as well as cartilage proves no barrier to its advance. In such cases, the destruction of the tissues being greater, the deformity is also proportionately greater.

The **prognosis** is quite favorable, although the disease can rarely be checked without the production of more or less destruction of the nasal septum, with at least permanent perforation. A sort of eczematous eruption is apt to persist even after the recovery from the lupoid ulceration, which is a matter of considerable annoyance to the patient and very difficult to overcome.

Lupus of the pharynx is much more rare than lupus of the nasal passages, and although appearing without any relationship whatever to syphilis, is, nevertheless, more often found in syphilitic subjects. It is stated by many authors that lupus is a disease which is found in tuberculous subjects or those of tuberculous tendency; indeed, as will be seen subsequently, many authors regard the two diseases as identical. This question, however, is still a practically unsettled one, and need not detain us here. The portion of the pharynx more often attacked is the soft palate, and of this the buccal, more frequently than the pharyngeal, surface. Next in order of frequency of occurrence may be mentioned the lateral wall of the pharynx, or rather the faucial arches, especially at their junction with the velum palati. In the cases of lupus of the pharynx which have fallen under my observation, the soft palate or the faucial folds have been the primary seat of the disease in all but one instance. The course of the ulceration in this situation is usually very mild, and leads to no more constitutional disturbance than when situated upon mucous membranes elsewhere, excepting as it interferes more or less with proper deglutition. In such instances the loss of body-weight and consequent development of general physical weakness is progressively marked during the period of ulceration. After cicatrization takes place, however, these difficulties disappear and the nutrition of the patient soon assumes a normal condition. In a case which has been under my treatment the ulceration and destruction of tissue was considerable for a time, and as deglutition grew extremely painful, the patient, in consequence of lack of food, became very weak. This case occurred in a woman whose family were free, as far as could be ascertained, of any tuberculous tendency, but who had suffered two years previously from a severe attack of small-pox—indeed, the skin all over the body presenting the marks or pits of the disease. We were unable to trace, however, any causal relation between the eruption of lupus and the variola; neither could there be traced in this case any syphilitic taint after the most thorough investigation into the life-history of both the patient and the patient's husband. I have ascertained of no instance on record of lupus of the nasopharynx.

The prognosis of lupus in these situations is favorable unless the disease circumvents the tonsil or some other hidden place where adequate local treatment cannot be pursued.

Treatment.—The local treatment should be a vigorous one, consisting of thorough excision or evulsion of the morbid tissues. For this purpose curettement and the galvano-cautery offer the most suitable means. After this has been done, persistent local application of resorcin, iodoform, sodium formate, guaiacol, or carbolic acid, or escharotics, such as zinc chlorid, chromic acid, etc. The general treatment by iodin, iodid of potassium, and arsenic will prove very efficacious, especially the former. In the case of lupus affecting the soft palate or pharynx so as to interfere with proper deglutition, 4 per cent. solution of cocain should be freely applied to the diseased parts just before a meal is taken, and the meal should be such as to contain the most nutritious constituents of alimentation. Out-door life and proper hygienic surroundings will add material benefits to any course of treatment.

Notwithstanding the fact that the tubercle-bacillus is so often absent in many specimens of lupous tissue, yet the majority of writers persist in ascribing the essential cause of the disease to the tubercle-bacillus of Koch, although the same observers note the discovery of the bacillus of Lustgarten as well. To account for the diverse clinical behavior of lupus, as compared with so-called tubercular affections of other tissues, Councilman believes that the quality of the bacillus and the resistance or definite reactionary characteristics of the tissue invaded are quite sufficient, holding, for instance, that the histological peculiarities of the skin will resist the development of the tubercle-bacilli in its tissues, and thus give rise to the slow and heterogeneous clinical phenomena observed in lupus.

LUPOUS LARYNGITIS.

Lupous laryngitis is a chronic inflammation of the mucous membrane, characterized by the formation of small nodules or tubercles in the deeper tissue—the submucosa. These nodules disappear either by resolution, exfoliation, or ulceration, leaving a peculiar cicatricial tissue. There are several varieties of lupus described by dermatologists, chief of which is lupus vulgaris—the variety usually found affecting mucous membranes. Lupus erythematosus has received its name from Cazenave on account of its healing with the formation of scar-tissue similar to lupus vulgaris. Many modern dermatologists and pathologists, however, think that it should not be classed with lupus vulgaris, because no tubercle-bacilli have been found in the tissue-formation of its eruptions. Unna, for instance, suggests that it be called seborrhea congestiva, and not classed with the tubercular affections. Besmier of Paris and some others argue that it is a tuberculous affection, and should therefore retain its present name. Leloir also believes that it is tuberculosis, and capable of reproducing itself by inoculation. The disease commonly attacks, and is confined to, the skin; but when the site is in the neighborhood of any of the orifices—such as the nares, mouth, ears, vagina, or rectum—it is apt to extend and involve the contiguous mucous membrane. Exceptionally, however, it affects the mucous membrane *primarily*, in which case the nasal or buccal mucous membrane, or that of the soft palate, pharynx, larynx, conjunctivæ, rectum, or vagina, may be the part affected. Leloir's statistics show (Morrow) that out of a total of 312 cases of lupus, mucous membranes were involved 109 times—the mucous membrane secondarily—yet primary lupus of the nose, a more common type than formerly supposed, may escape notice. Neisser concludes that lupus of the face is generally caused by extension from adjoining mucous tracts, especially from that of the nose. The internal mucous membranes, such as the gastric, intestinal, or bronchial, are not subject to invasion, although a case is reported where the process was observed on the mucous membrane of the trachea.

Primary lupous laryngitis is quite rare, many laryngologists of large experience not having seen a case, while others have seen but very few cases each. Among these, Bosworth mentions having seen but one, M. Mackenzie two, Lefferts four, and Rice three. As the invasion is insidious and very chronic, and the signs of the same very obscure, many observers believe (as also of the nasal mucous membrane) that the disease occurs in the larynx oftener than is supposed—especially as it generally attacks the young, who do not come under observation as readily as older persons. Among these observers, R. De la Sota y Lastra and Rice make this suggestion. The epiglottis is generally the part attacked, according to Chiari and Riehl.

Symptoms.—The constitutional disturbance incident to this affection is practically slight, unless the disease is so situated or so advanced as to interfere with the functions of deglutition or respiration, or unless some complication attended by unusual inflammatory or septic processes in the neighboring glands or tissues supervene. Such complications are rare, however, until the disease has run a very long and aggravated course; for there is usually but little tendency to general infection of any sort, although Leloir and others say that it may produce partial or general infection. Hoarseness and a sense of dryness or thickening referred to the throat, with slight dysphonia or dyspnea, are among the early and, it may be said, persistent symptoms. There is little or no pain complained of unless the disease is advanced and extensive, or ulceration with an unusual amount of inflammation has taken place, when more or less difficulty of swallowing may occur, although not even then very much. When there is much swelling, attention is required in order to prevent the ingress of particles of food into the larynx during the act of deglutition. The temperature rarely rises until the disease is quite advanced and complicated, and then perhaps only to 99° F. The local appearances are usually less marked on mucous membranes than on the skin. Michelson has shown that it is almost impossible to trace accurately the limits which separate the lupous tissue from the mucosa, because it is only in the cicatrices that we find the characteristic lupous nodule when the mucous membrane is the seat of disease.

The laryngeal face of the epiglottis is usually first affected, and presents a slightly swollen hyperemic condition with a few papular projections like granulations, which afterward break down into an ulcerated patch (see Fig. 618). In some cases the free border of the epiglottis appears whitish or gray, thickened and studded here and there with dark-red papillomatous patches. After a while the laryngeal vestibule becomes altered in shape from the infiltration, etc. The thickened and misshapen mucous membrane presents irregularly circular folds or rugæ, appearing similar to a slightly prolapsed and puckered membrane, and is studded here and there with grayish glistening fissures and dark-red papules, which in turn may be coalesced to form a patch. These places are not very painful to the touch nor during swallowing. At a later stage these spots become softened and soon show evidences of slow, dry ulceration bounded by ragged edges or a slightly reddened granular areola. According to Leloir and contrary to Baumgarten, suppuration of the lupous patch is not an essential characteristic, and when present is due to the combined action of the agents of suppuration (streptococci) and the bacillus of Koch. If the seat of the disease be the border of the epiglottis, it may appear as if worm-eaten (Lastra). Even now the swelling and hyperemia of the surrounding parts may be quite insignificant; for the infiltration seems undulatory and very chronic, so that the general condition of the patient may remain good in every particular. The progress of the disease is so slow that it may cover a number of years, and then may terminate in pulmonary or meningeal tuberculosis or epithelioma (Morrow), although not necessarily, for many observers have never known a case in a tuberculous subject (Bosworth). At the same time, the local process during this period is subject to great variations of exacerbation and quiescence. This is true of lupus affecting mucous membranes as well as the skin.

A retrogression is marked mainly by a gradual healing of the ulceration, with the formation of a thin, bluish-gray, glistening cicatrix, somewhat more moist and duller, however, than the lupous scar-tissue of the skin, and surrounded by zones of thickened, rough, dark mucous membrane. Then after a period of quiescence more or less prolonged (which in some cases leads one to the conclusion that a cure has been effected) there is a recrudescence, which at the time may not be accounted for by any event in the domestic or clinical history of the patient. It will now be observed that two or more foci of papillary swelling with inflammation are starting from about the periphery of the old lesion. These may perhaps go through a more rapid or aggravated course of softening, tumefaction, and ulceration, etc., and may be accompanied by more infiltration of the surrounding tissue than at the former period. Indeed, some cases present a greater severity of local action at each successive exacerbation, so that the ulceration and inflammation may become somewhat alarming, while the ulceration perhaps assumes the serpiginous form spoken of by some writers. This event is quite dangerous when affecting the larynx, and apt to be extensive in its ravages, simulating to a certain degree lupus exulcerans (lupus exedens) of the skin. Besides this, the corresponding cicatrices from such an amount of destruction leave troublesome and sometimes vicious deformities, which may endanger life through interference with the laryngeal or esophageal openings (stenosis).

Etiology.—Lupus was formerly regarded as related to scrofula, or cancer—if not really cancerous—by the older authors, mainly on account of the observation of cases becoming cancerous. It was also considered a sequence of syphilis. Ricord held that it was an inherited manifestation of tertiary syphilis. Kaposi, however, says positively that syphilis in a parent has no connection with lupus in the children; moreover, Hebra and Kaposi have found recent syphilis and lupus in the same individual. The latter (syphilitic) view is to some extent prevalent nowadays. Again, it has been considered a scrofulous disease; but as so-called scrofula is generally considered to be of tuberculous nature, or practically a form of tuberculosis, this view would coincide with the opinion now prevailing that lupus is a *local chronic tuberculosis!* Some authorities have believed, and do yet, that lupus vulgaris, especially in the skin, belongs to the scrofuloderms; that it is essentially a scrofulous disease! Kaposi and others combat this idea, and say in effect that scrofula is entirely absent in many cases of lupus. Indeed, it is now so classed by the majority of modern dermatologists and pathologists, and may be found in the category with tuberculosis verrucosa cutis, scrofuloderma (tuberculosis of the subcutaneous tissue), tuberculosis cutis, etc.

The tubercular nature of lupus was suspected for years before the discovery of the tubercle-bacilli of Koch, on account of the histological analogies between the several affections as persistently pointed out by Friedländer and others; but the hematogenetic origin of lupus was not assailed until the discovery of the tubercle-bacilli in lupous tissue (lupoma) by Demme, Koch, and afterward by others, when all doubt seemed to be swept from the minds of the majority, and the tubercle-bacilli (as in other tubercular disease) became the recognized cause of lupus vulgaris. Moreover, these views have been strengthened from time to time by experimental and other observations apparently showing the inoculability and infectiousness of lupous tissue, for J. Jadassohn, Leloir, and others have cited instances of the production of lupus by inoculation, and they regard every case of lupus vulgaris as due to inoculation with the tubercle-bacillus, thus denying the so-called hematogenous development of the disease as promulgated by Baumgarten. Koch, Leloir, and others claim to have demonstrated this by the transmittal to guinea-pigs and rabbits of tuberculosis by inoculation with lupous tissue-cultures. The starting-point is probably the entrance into the skin or mucous membrane of the tubercle-bacilli in one of the following ways: 1, indirect inoculation from without; 2, indirect inoculation by continuity from deep tuberculous foci; 3, inoculation by way of lymphatics or the veins passing through a tubercular focus more or less remote; 4, infection of hematic origin; 5, infection by inheritance.

Methods 1 and 2 are probably the most frequent. However, there are no instances, I believe, where lupus has been a result of contact (contagion) of one lupous patient with another, nor where the inoculation of bacilli into the skin experimentally has produced lupus. Kaposi and other European dermatologists, and Duhring in this country, are rather skeptical as to the identity of lupus with tuberculous affections. Kaposi says: "Nevertheless, the attempted demonstration of the identity of scrofula, tuberculosis, and lupus has not yet proven such identity. Cases of 'inoculating tuberculosis' are reported in constantly increasing numbers, but it seems to be regarded as immaterial that years may have elapsed between the assumed 'inoculation' and the occurrence of the tuberculosis of the skin. No experimental proof has been offered, however, that characteristic lupus vulgaris can be produced by inoculation of tubercle-bacilli." Drs. Morison and Symington[1] examined the tissue from twenty lupous cases without finding the tubercle-bacilli, and M. Cornil examined the skin of eleven lupous patients, and found only one tubercle-bacillus. Dr. Henneage Gibbes believes lupus a tubercular affection, but says that the bacilli are sometimes not found in the lupous tissue. Kaposi and others deny the infectiousness and heredity of lupus; but cases have been recorded where a parent of a patient suffered from lupus, and an instance where several brothers and sisters of another patient suffered from lupus. Leloir again says that diversity in the phenomena of the several varieties may be accounted for by the mode and seat of the inoculation (inoculation from within outward or from without inward); the deposit of the virus in parts more or less vascular; the greater or lesser virulence of the virus inoculated, and different degrees of reaction of the tissues. All authorities agree that it is a disease of early life. According to Leloir it begins generally in infancy, and may produce partial or general infection of the system. Concerning the exciting causes of lupus, especially as regards the mucous membrane, there seems to be a paucity of positive information. Syphilis and eczema of the nose, and fistulæ leading to the site of tuberculous disease, are cited as having induced the formation of lupus in a few cases; but mechanical or chemical injuries are not spoken of as probable causes of the disease in mucous membranes, unless we accept the theory of those who believe in the direct or indirect inoculation with tubercle-bacilli, and who think that a previous abrasion is necessary for the introduction of the germ. Leloir's classification of the varieties, all varieties which he believes are tubercular, is as follows:

(*a*) True lupus, non-exedens and exedens.

(*b*) Atypical varieties of lupus: 1, lupus vulgaris calloide; 2, lupus vulgaris myxomatosus; 3, lupus vulgaris sclerosis and demi-sclerosis; 4, lupus vulgaris erythematoid.

(*c*) Scrofulo-tuberculosis, gummata-dermatic and hypodermatic.

(*d*) Ulcerative tuberculosis: 1, secondary; 2, primary.

(*e*) Mixed tegumentary tuberculosis resulting from a combination of two or more of these varieties.

A review of the conflicting literature upon the etiology of lupus from a clinical standpoint might lead to the following considerations:

(*A*) If lupus is due to the presence of the tubercle-bacilli, and therefore of the same pathological nature as the other so-called local tuberculous diseases, how can its peculiar clinical course, which is much at variance with that of other of the tubercular affections, be accounted for? Is there in the histological, biological, or chemical constituents of either the skin or mucous membranes at the orifices of the body any special antidotal property, in the form of either serum, cell, proteid, ferment, secretion, or tissue, which will so effectually resist the development or growth of tubercle-bacilli or the extension of their accompanying toxins as almost to nullify their hitherto-accepted destructive tendencies?

(*B*) What, also, is the reason that the implantation of tubercle-bacilli in the mucous membrane of the larynx in one instance produces a slow-going, practically non-infectious local disease (lupus); while in another instance the same micro-organism rapidly develops, extends, and thereby sets up a destructive local disease and a fatal general infection?

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[1] *Journ. Cut. and Gen.-Ur. Dis.*, vol. ix. p. 268.

I confess that all the explanations with which I am familiar touching these points are inadequate to explain these clinical anomalies. The histological resisting character of the skin or its temperature and movements is urged by some observers in explanation of the very chronic and innocuous course of this disease. The paucity of the tubercle-bacilli and their encapsulation—contributing to render them latent—is stated by Unna. Lastra, however, seeks to account for the incongruities observed by the supposition that the bacilli or their accompanying toxins may be attenuated, and in substantiating this view he reasons by analogy, and ingeniously cites the effects of attenuated doses of chemical agents on the system as compared with larger quantities or more concentrated qualities of the same, thus assuming that the cytogenesis or mitosis of a part depends upon the dosage. According to Unna, the smallest number of tubercle-bacilli are able to stimulate productive inflammation, the formation of giant cells, and serofibrinous exudation; but be that as it may, could we, under even these conditions of attenuation, expect any such pathological process in the mucous membrane of the larynx, a part whose susceptibility to tubercle-bacilli and tuberculous toxins are continually alleged as a matter of fact? Either we have not yet fully learned the morphology of the tubercle-bacillus, or we must look upon the doctrine as a fiction that it (tubercle-bacillus) is independently the cause of lupus of the larynx. There is no use of taking up space by theorizing, but it seems certain from the clinical history and pathological anatomy of lupus vulgaris of the larynx that its etiology depends essentially in some way upon a perverted or aberrant (karyokinesis—catogenesis—or mutations) process of regeneration of the constructed or formed tissues of the part, or that the bacillus of lupus, instead of being identical with the real tubercle-bacillus of *ordinary tuberculosis*, is perhaps more closely allied to the bacillus of Fisch, which is found in rhinoscleroma.

Age.—All authorities agree that lupus is a disease of early life, although there are instances on record of its occurrence at an advanced age.

Sex.—The female sex seems to be more susceptible than the male. Of 79 cases collated by Bosworth, 51 were females and 18 males. Other statistics on this point coincide.

Heredity.—There have been differences of opinion regarding the hereditary transmission of lupus, but unquestionably the instances of such transmission are rare.

Inoculability.—I think the majority of dermatologists believe that the disease is inoculable, either directly or indirectly; but as that question has been dealt with in the discussion of the etiology, there is nothing to be added here, excepting to recite the oft-quoted verdict of the territorial jury—viz., "*not proven.*"

Traumatism has been cited as a predisposing cause of the disease in the skin, and, by those who accept the doctrine of inoculability of the disease, is believed to be an important etiological factor.

Pathology.—According to Prudden and Delafield, lupus consists in the presence of "small multiple nodules of new-formed tissue, somewhat resembling granulation-tissue, in the cutis mucosa or submucosa. By the formation of new nodules and a more diffuse cellular infiltration of the tissue between them, the lesion tends to spread, and by the confluence of the infiltrated portions a dense and more or less extensive area of nodular infiltration may be formed. There may be an excessive production and exfoliation of epidermis over the infiltrated area, or an ulceration of the new tissue."

In the clinical group of diseases called lupus there are other forms of lesion which are not caused by the tubercle-bacilli.

Unna lays great stress upon the part played by the large so-called plasma-cells of Waldeyer, and thinks the giant cells are of secondary formation. He also points out that the tubercle-bacilli are encapsulated in the giant cells, and therefore become latent. Jadassohn thinks the plasma-cells are not of any particular importance in lupus, because occurring in other inflammatory processes.

Kaposi says that the pathology of the disease relating to the skin does not differ essentially from that affecting the mucous membrane.

In all instances of tuberculosis we find the tubercle the product of the tubercle-bacilli—a nodule of so-called granulation-tissue, composed histologically of small round cells, deeply stained by coloring-agents, together with larger cells possessing a clear nucleus that have been called epithelioid cells, and large cellular elements, with peripherally arranged nuclei and homogeneous center, the Langhans giant cells. These cells are enclosed between the meshes of connective tissue, and are characterized in distinction from normal cells by their instability. Sooner or later a modification begins in the nodule. Its center becomes necrotic—*i. e.*, the cell-protoplasm is coagulated, the nuclei lose their power of responding to staining-agents, the intercellular substance also takes part in the degeneration, and there results a coagulation-necrosis in the Weigert sense—a condition that has been called cheesy degeneration.

Diagnosis.—Lupus of the larynx may simulate tuberculosis, syphilis, epithelioma, rhinoscleroma, or chronic glanders. According to Neisser (Morrow), the chief diagnostic points of lupus are the beginning in childhood and its very chronic course. If the lupus laryngis be secondary to the same disease of the skin or an extension from it to fauces and larynx, then the diagnosis may be easily made out. But when the larynx is primarily affected the task may be a more difficult one, at least in some of its stages.

The general clinical history, showing an absence of constitutional disturbances of any moment, will serve to distinguish it from laryngeal phthisis, and from syphilis by lack of the history belonging to the latter disease. On inspection, the absence of much inflammation, the dry, negative, unsuppurating appearance of the ulceration, limited in situation and not clearly defined, with rather coarse granulated edges, will usually serve to differentiate it from the sharply-cut suppurating ulcers of syphilis surrounded with highly-colored and tolerably well-marked areola, and from the shallow roundish lenticular ulcers on a pale and swollen mucous membrane which distinguish from syphilis and tuberculosis this disease. When ulceration is active the local appearances might lead to some confusion, but in such cases the clinical history, as well as the characteristics of the local formation, will remove perplexity. Syphilitic ulceration of the nose often resembles lupus, and diagnosis in such cases may have to be suspended to await developments.

Rhinoscleroma usually begins first on the skin of the nose. Its ulceration is flat and soon covered by a stiff crust. There is usually no softening nor ulceration, nor very much contraction, and no such melting away, so to speak, of the tissues as in lupus.

Epithelioma can only be mistaken for lupus when it is of local origin in the larynx, which is not often. When so occurring it is generally situated at first either upon the epiglottis or in a laryngeal ventricle. It may be seen as a more or less reddish growth of uneven although unbroken surface and to stand out from the tissues. When breaking down it presents sinuous slough-patches or pockets and granulations, but no cicatricial tissue.

Treatment.—The treatment should be both constitutional and local. The systemic treatment should be upon the tonic and so-called alterative plan. The subjects of lupus more often than otherwise show the effects of privation or malnutrition. Therefore, a generous diet, out-door life, and suitable clothing, together with such tonics as salicin, quinin, Fowler's solution of arsenic, tincture of the chlorid of iron, etc., should be administered.

Arsenic in one form or another has been considered highly beneficial for the last century. Indeed, it has been deemed by some as almost a specific for lupus. It certainly is one of the most useful remedies in vogue. Iodin and iodid of iron are also of great value, especially if combined with the syrup of the hypophosphites. In my limited experience the use of arsenical preparations and iodin, either hypodermatically or by the mouth, has given the best general results. Iodid of arsenic and Fowler's solution are the favorite preparations. Cod-liver oil and malt-preparations may also be taken with benefit. When there is a cachectic sallow appearance with tendency to lymphadenitis, phosphorus in oil should be given three times a day.

The chief indication for local treatment is the removal of the offending tissue. This has always been the desideratum. The older practitioners sought to accomplish this elimination by means of powerful caustics, such as caustic soda, caustic potassa, arsenious and nitric acids, chlorid of zinc, etc. More recently the dermatologists have resorted to either the knife or curette for the speedy removal of lupous tissue. This surgical plan has also been adopted in cases of lupus of the mucous membranes, but according to Bosworth with the effect of aggravating the disease. Undoubtedly, when so situated that the diseased tissues can be wholly cut away at once, such an operation would be performed.

The use of the galvano-cautery ought in many cases to supersede other escharotic treatment, although strong solutions of chlorid of zinc or lactic acid are very satisfactory in their effects. The case which I have cited was treated locally, mainly by occasional applications of lactic acid followed by daily applications of a spray of a strong solution of resorcin. Pyoktanin, topically applied as Bougard's paste or injected into the parts by the hypodermatic syringe, is reported as being efficient. I have used a solution of iodin in this manner, but could not see that the effects were more striking than when introduced elsewhere under the skin. The application of balsam of Peru has been reported as giving good results. There is danger of producing edematous or phlegmonous inflammation of the larynx by rough treatment; for that reason it is obvious that the same thorough treatment as applied to the skin would be inadmissible for application to the larynx. For routine local treatment it will be found that resorcin or iodoform, or both, in conjunction with the careful use of the galvano-cautery, lactic or chromic acids, will constitute the most efficient and safest treatment for this disease.

The use of tuberculin and tuberculocidin seems to have been abandoned.

LEPROSY OF THE AIR-PASSAGES.

Leprosy often involves the mucous membranes in the course of the general affection, and its lesions might be confused with the others here considered; but it is probably always secondary to the cutaneous manifestations of the disease, which should make clear the diagnosis, and is too rare to demand discussion here.

SYPHILIS OF THE AIR-PASSAGES.

By WILLIAM C. GLASGOW, M. D.,

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Next to the skin, the respiratory tract furnishes the most frequent manifestations of syphilis. Owing to the slight disturbance caused by the initial and secondary lesions, these are often overlooked; and the latest stage, from its greater destruction of tissue and its marked disturbances, has been placed in greater prominence as a factor in the disease. The initial lesion here has been considered by many to be only a possible contingency; and they are apt to ascribe the infection to a hidden chancre of the genitals. The observation of men of large experience has proven, however, that syphilis may be "insontia;" that occurrence of the extra-genital chancre is not rare; and that its possibility must be considered in all cases where the initial lesion is not plainly apparent. The secondary lesions of the upper air-passages are always more or less evident. To differentiate them from similar conditions due to other causes is not always easy; and in some cases a positive diagnosis can be made only through the presence of the well-known lesions of the skin. Tertiary lesions are usually marked and distinctive, and in only a small percentage of cases can there be any doubt. According to anatomical classification, syphilis of the air-passages may be divided into diseases of the nose, diseases of the pharynx, diseases of the larynx, diseases of the trachea, and diseases of the lungs.

SYPHILIS OF THE NOSE.

Primary syphilis of the nose is acknowledged by all authorities to be very rare. When we consider the uncleanly habits of certain people, and the frequent interchange of handkerchiefs and towels among the members of the family, by which means infection can be so readily carried, and also the frequency of abrasions at the entrance of the nostrils, we are surprised that it does not occur more frequently. Buckley, from an analysis of 9058 cases of extra-genital syphilis, gives 95 cases occurring in the nasal cavity. In his personal experience he has found one case occurring in 113 cases of extra-genital syphilis. He thus describes the symptoms of this case: "There was great swelling of the left nostril, which stood open and was covered internally with a dry crust, and on the margin there was an ulcerated surface free from crust. The passage of the nose was red and uneven from small nodular masses." There was no history of a preceding syphilis, and the lesion was suspected to be a chancre, rather than a later manifestation of the disease. Under the mixed treatment, and calamine and zinc ointment applied to the lesion, there was great improvement with healing of the ulcer. Secondary syphilis appeared later, confirming the diagnosis. The infection in this case seems to have come from the use of an infected towel. The most frequent site of primary lesions in the nose is the cartilaginous septum, and the infection is usually carried by the finger-nail. In some cases the surgeon is responsible through the use of unclean instruments. Several cases are recorded of infection by the Eustachian catheter. Bosworth describes a case of Moure: "The ulcer presented a large granular mass which bled easily upon touch, and which not only produced notable stenosis, but also pressed upon the ala of the nose to such an extent as to produce a marked deformity." In a case of Watson, the base of the chancre presented the appearance of a hard cartilaginous tumor with an ulcerated surface which bled easily upon touch, and projected so far into the nostril as to produce a marked stenosis.

An indolent swelling of the submaxillary glands is constant at this stage, and the constitutional disturbances of early syphilis are often witnessed. Erythema or a subacute rhinitis is the one pronounced symptom of the secondary stage. If mucous patches occur, they must be exceedingly rare. The "snuffles" of the new-born child is one of the frequent symptoms of congenital syphilis.

Syphilitic rhinitis differs in appearance in no way from an ordinary rhinitis. The diagnosis can be made with certainty only when the lesions of the skin show the recognized eruptions of syphilis. Its duration, however, is longer than a simple catarrhal rhinitis; and this chronicity and resistance to treatment add to its suspicious character.

The third stage of syphilis shows the most marked manifestations in the nose, causing ulcerations, superficial and deep, and gummata. Gummatous deposit may occur in any portion of the nose. The most frequent site is the septum and the floor of the cavity. It is most commonly limited in extent, forming a tumor as large as, or larger than, a pea. In some cases, however, the infiltration is more extended. It commences most frequently in the submucous tissues, extending both to the surface and the deeper tissues. It may continue for months with an unbroken surface; but sooner or later degeneration occurs, and ulcerations, either superficial or deep, result. The periosteum or perichondrium becomes involved, and later there is necrosis of the bony structures. The septum is a frequent site of ulceration, especially the junction of the cartilaginous with the bony septum. Perforation of the septum is a common result. Many consider a perforation of the septum to be an evidence of syphilis; but experience shows that the perforation may be due to the breaking down of a tubercular infiltration or may be the result of any constant and repeated irritation of the septum. Where the bony septum is involved, the existence of syphilis is unquestionable. Next to the septum, gummata are seen most frequently in the floor of the nasal cavity. The mucous membrane and the submucous tissues, with the underlying bone, are involved, and perforation of the hard palate occurs. Frequently gummata are found in other portions of the nasal cavity, producing necrosis of the bones and great development of fibroid tissue. The deformity resulting from the destruction of the bony frame-work of the nose and the shrinking of the fibroid tissue produces the typical saddle-nose which is characteristic of syphilis.

The **symptom** of the early stage of nasal syphilis is a profuse secretion. It can hardly be distinguished from that of a catarrhal rhinitis, except that it is more obstinate and resists ordinary treatment. When it occurs in the new-born it is probably syphilitic. In the later stage there is a great tendency to the formation of crust with a muco-purulent secretion; the peculiar fetor of dry or syphilitic caries is unmistakable. With the formation of the gummata there is more or less obstruction of the nostrils through edematous swelling. When degeneration takes place beneath the mucous membrane, or when perichondritis exists, there is always more or less pain until the pus reaches the surface.

SYPHILITIC LESIONS OF THE PHARYNX.

Lesions of the pharynx occur in some form in the majority of cases of syphilis. The chancre or primary infiltration is more common than is ordinarily believed, and it is often overlooked owing to the insufficient illumination of the pharynx during examination. Excluding primary lesions of the lips and tongue, we find the tonsils to be the most frequent site, and, next to this, the soft palate. Contrary to the usual belief, infection in these cases has taken place most frequently through the use of pipes, eating-utensils, and public drinking-cups. The use of the last seems to be the most common source of infection. We can well imagine that the use of a cup by one having mucous patches on the lips would carry the infective material to the next one who used it. Unclean practices are responsible for only a limited number of cases. Referring to Table 3, published by Buckley, we find 307 cases of chancre of the tonsil among 9058 cases of syphilis. Schadek, among 68 cases of extra-genital chancres found in the fauces, locates 34 on the tonsil.

Chancre of the tonsil presents the appearance of an indurated ulcer of the organ, which may be limited in extent or involve a large surface (compare Fig. 575). The ulceration is superficial, but may be small, with its base covered with dirty-gray secretion. The indurated condition of the periphery declares the diagnosis, which will soon be confirmed by the glandular swellings and the lesions of the skin. In some cases the symptoms of the chancre are so slight as to escape notice ; in others they are marked. Pain may be very prominent, either confined to the pharynx or radiating to the ear. The submaxillary glands become swollen, but their suppuration is rare.

Erythema of the fauces is frequent. We find a circumscribed redness of the mucous membrane involving the soft palate, the pillars of the fauces, or the tonsil. The color is a coppery-red, and it is sharply limited to certain areas. Frequently it is confined to one side, with a well-marked line of demarcation in the median line and in the line between the hard and soft palates. Occasionally we find patches of congestion on the two sides, with the median line free—the so-called "Dutch garden symmetry" (Hutchinson). This condition usually coincides with the early skin-lesions of syphilis, and is often overlooked, as it rarely gives any special symptoms. Erythematous patches may be present in the naso-pharynx, giving rise to catarrhal symptoms. We occasionally see in those who have passed through the secondary stage, perhaps years afterward, the occurrence of a subacute angina, which will yield only to the specific treatment. In a case of the writer, an angina which had been under treatment for a long time by several physicians yielded at once to a mixed treatment, and the redness entirely disappeared. With the cessation of treatment owing to an attack of grippe, the angina returned, and permanently disappeared only after a prolonged specific course.

Mucous patches are of frequent occurrence in secondary syphilis. They are found on the pillars of the palate, the tonsil, and other parts of the buccal cavity. They are usually circumscribed in extent, presenting small patches of a mother-of-pearl color. As a rule, they are level with the surface of the mucous membrane, and are brought into greater prominence through the congestion of the surrounding tissues. They present somewhat the appearance of the mucous membrane after the surface has been touched with nitrate of silver. In a certain number of cases we find the patch thickened and somewhat raised above the surface, resembling in a certain degree the patches of diphtheria. They have a tendency to remain unchanged over long periods, unless modified by treatment. Occasionally we see the infiltrated patches presenting ulcerations and erosions. These are superficial in character and have a tendency to extend at the periphery. Secondary lesions appear from six months to two years after infection.

Tertiary syphilis of the pharynx is strictly the result of a gummatous infiltration of the tissues, the mucous membrane, the submucous tissues, or the bones. Manifold in its pictures, modern medicine ascribes all these conditions to degeneration of the gummatous infiltration. More or less rapid ulceration, with great destruction of tissue and the development of a cirrhotic contractile tissue, is the usual sequel. Gummatous tumors may be confined to limited areas, or the deposit may be extensive. Unless checked by treatment, they may break down rapidly, giving rise to ulceration, which in the beginning may be small and may occur at several points. If unchecked, it is prone to extend, producing great destruction of tissue. The ulcer may be round or irregular, and is surrounded by a red areola. It has sharply defined edges, and its base shows feeble granulation-tissue exuding secretions composed largely of pus and broken-down epithelium. The posterior pharyngeal wall is a frequent site of the gummatous infiltration and extensive ulceration. Superficial ulcers frequently occur in the upper part of the pharynx, and are hidden from view unless discovered through a rhinoscopic examination. When the ulcers extend deeply into the tissues, they may involve the periosteum with a subsequent caries of the bone.

The posterior surface of the palate is a common site of a softening gumma. The destructive process may be very rapid, and perforation of the palate is quickly established; unless checked, the eroding process may continue until more or less of the palate is destroyed. The dependence of the ulceration upon the gummatous deposit is strikingly shown in some of these perforations of the soft palate, where we see large areas destroyed, with normal strings of tissue remaining between the perforations. Ulcers of the tonsil are not usually as large as those of the palate; they are more longitudinal, and show less tendency to extend. Several ulcers may be seen at the same time on the tonsil with sound intermediate tissue. The deep perforating ulcer has occasionally produced erosion of a blood-vessel with hemorrhage. Gummatous tumors occur on the posterior pharyngeal wall and the hard palate, where they show little tendency to soften. They appear as hard, firm, rounded tumors covered with mucous membrane. They may be quite large and present the appearance of a fibroma or a sarcoma. A case of the writer presented a gummatous tumor of the tonsil, as large as a small hen's egg, largely blocking up the fauces. In some of these cases the diagnosis is difficult, and can only be affirmed after a microscopical examination or the test of treatment.

Another result of gummatous infiltration is seen in the development of contraction and scar-tissue. A great and varied distortion of the pharynx is the result, and membranous folds are formed which cause great inconvenience and distress. Adhesion of the soft palate to the posterior pharyngeal wall, often complete, or with a small opening, is not uncommon. A membranous adhesion between the lower pharynx and the root of the tongue, largely closing the larynx and esophagus, has several times been observed. Such a case came under my observation a few years ago. The opening was large enough to allow free respiration, but great difficulty was experienced in swallowing. Adhesions between the soft palate and the palatine folds are of frequent occurrence. They are usually unilateral.

Symptoms of secondary syphilis of the pharynx may differ but slightly from those of an ordinary catarrhal pharyngitis. There may be a sensation of dryness of the membrane, and more or less pain on swallowing. The secretions are usually increased. The glands of the neck are swollen; but this may also result from other causes. The occurrence of the tertiary stage gives rise to more prominent symptoms. The pain of swallowing may become so intense as almost to preclude the taking of food. It may radiate to the ears and assume the form of a neuralgia. The secretions are greatly increased, and become purulent and ropy. When the palate is involved either through infiltration or ulceration, we find a disturbance of the speech, and fluids are often regurgitated into the nasal cavities.

SYPHILITIC LESIONS OF THE LARYNX.

The larynx becomes involved in a large number of cases of syphilis. The disease may be in the milder forms, and be overlooked, or in the most destructive, which cannot escape notice. Authorities are greatly at variance as to its frequency, laryngologists meeting a larger percentage of cases than the dermatologists. In a large number of cases laryngeal syphilis appears secondary to syphilis of the pharynx. It has, however, been frequently observed independently, often occurring many years after the initial lesions. It may occur in varied forms from two months to fifteen years after infection. Primary syphilis of the larynx is almost unknown, although it has been reported. Secondary syphilis has been observed as early as the second month—the usual time is from six months to three years after the infection. It assumes the forms of an erythema, mucous patches, and erosions.

Erythema or syphilitic catarrh is an early and most constant lesion. It resembles so closely an ordinary catarrhal laryngitis that in many cases it is impossible to make a differential diagnosis unless it is accompanied by the skin-lesions. Even in such cases the occurrence of laryngeal hyperemia may be an accidental condition of ordinary catarrhal laryngitis in a syphilitic subject. The true nature of the lesion can be determined only by the result of treatment. In certain typical cases the color of the membrane is of a deeper red than that of an ordinary catarrhal hyperemia. It is more persistent, and there is usually a greater swelling of the membrane. In other cases it is found confined to limited areas. Mucous patches are not frequent. They have been reported as occurring on the under surface of the epiglottidean folds, the true and the false cords. They are similar in appearance to the mucous patches of the pharynx. They seem to be the origin of the erosions which are often seen in the larynx. Occasionally they present the appearance of condylomata.

Symptoms of the second stage are obscure, and will depend upon the area affected. When the vocal cords are concerned, the symptoms resemble those of a catarrhal laryngitis; the voice may become rough and hoarse. If the arytenoid cartilages or the interarytenoid fold are involved, the patient may have an irritative or tickling cough and clearing of the throat. The tertiary lesions of the larynx appear from the third year of infection on to an indefinite period. Cases are on record in which the laryngeal affection has arisen twenty years after the primary lesion. It assumes the form of a gummatous infiltration or tumor; and when softening occurs there is ulceration, and the gummatous infiltration will present the appearance of a thickened, infiltrated area. This may extend through the submucous tissue, involving the perichondrium, while the mucous membrane of the affected area may be normal or reddened. The epiglottis is the most frequent site of the infiltration (Fig. 620), but it is also seen on the true cords, false cords, and the ary-epiglottidean folds. The epiglottis may be changed into a swollen, deformed organ, and the ary-epiglottidean folds become large and prominent: the swollen false cords may largely fill the glottic opening. Gummatous tumors are simply circumscribed areas of infiltration which develop into the form of a tumor (Fig. 621). They occur in all parts of the larynx, and may be single or multiple. The tendency of the gummatous formation is to soften, and when this occurs the destructive process is very rapid. It burrows deeply in the tissues, producing a deep, excavated ulcer, with destruction of the underlying cartilage. The epiglottis may be partially eroded or completely destroyed through the necrotic process. The crico-arytenoid joint and both the true and false cords may be involved in the same process. The collateral edema and swelling may be so great as to occlude the glottis. The deep ulcer of syphilis has a certain characteristic appearance: the edges are sharply defined, and the base is covered with gray secretion. In form it is irregular and it is surrounded by infiltrated tissue. The superficial ulceration is not so characteristic. It may have an extensive surface, and has a great resemblance to a tubercular ulceration.

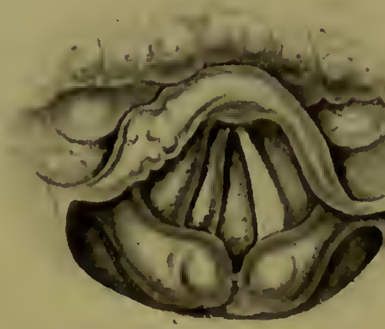

Fig. 620.—Fresh gummata on the epiglottis and syphilitic infiltration of the right true vocal cord and ventricular band (Grünwald).

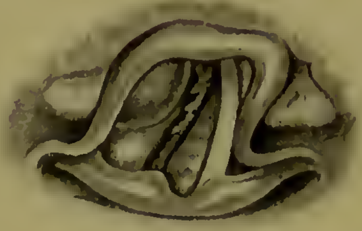

Fig. 621.—Tertiary syphilitic deposits in the right cord and ventricular band with gumma of the adjacent part of the epiglottis (Grünwald).

The differential diagnosis between a syphilitic ulcer of the late stage and the tubercular will often be difficult and at times impossible, without the consideration of other signs and symptoms of the disease; this will especially be the case where a mixed infection is present (Fig. 622). The syphilitic ulcer has sharp, better-defined edges; it is apt to be single, and presents the appearance of an excavated area with a reddened, thickened surrounding. The tissue about a tubercular ulcer shows an anemic color. A common sequence of the ulceration will be found in the development of the contractile scar-tissue, which produces great distortion of the laryngeal structures and which remains permanently, giving in after years positive evidence of the disease. Adventitious membranes may be formed between the cords, largely closing the glottis.

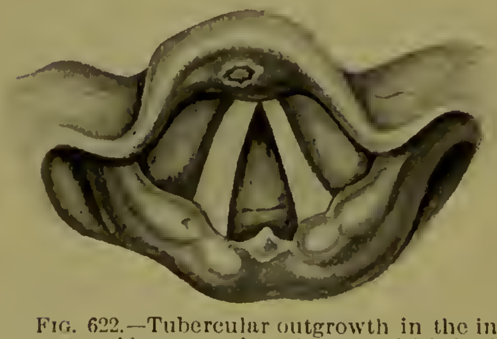

Fig. 622.—Tubercular outgrowth in the intra-arytenoid space and tertiary syphilitic infiltration and ulcer of the epiglottis (Grünwald).

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SYPHILIS OF THE TRACHEA.

Syphilis of the trachea assumes the form of erythema in the early, and gummatous infiltration in the later stage; it is frequently consecutive to the disease in the larynx. Erythema of the trachea can be discovered only through the use of the laryngeal mirror. There are no symptoms, unless there be irritating cough. The gummatous ulcer can occasionally be seen in the mirror, if it occurs on the portion of the trachea which can be illuminated. It is more frequently entirely overlooked, and is suspected only when the development of stenotic symptoms shows the presence of contractile scar-tissue. It may be multiple, and invade large areas of the trachea, and it may be superficial or deep. The deep ulcer may break down the cartilage and form a connection with the adjacent organs. Contractile adhesions may result, largely occluding the lumen of the trachea. In a case of the writer the upper portion of the trachea was almost entirely closed by adhesions; the patient survived fourteen years after a low tracheotomy.

SYPHILITIC LESIONS OF THE LUNGS.

That syphilitic lesions of the bronchi and lungs occur has been proven by post-mortem examinations, but the diagnosis in most cases is extremely difficult, if not impossible, during life. Post-mortem specimens have shown the presence of the gummatous infiltration, and this has been found broken down, forming cavities. Syphilitic phthisis can only be suspected when it occurs in a person subject to syphilis, and even then a possibility of a mixed infection must be considered. The physical signs and symptoms are similar to those occurring in many cases of ordinary phthisis, and it resembles those cases which have been justly termed a local tuberculosis of the lungs. The general symptoms are slight, and emaciation is not so marked as in tubercular phthisis. The physical signs will show a local infiltration confined to single portions of the lungs. We may have the moist râles and bronchial breathing with dulness, if a perceptible area has been infiltrated: the cavity signs will be present where an abscess has emptied into a bronchus. The iodid-of-potash test will be the leading element in the diagnosis.

TREATMENT.

The treatment of syphilis of the respiratory tract follows the rules of the treatment of general syphilis, with the addition of such local treatment as may be needed in individual cases. The accepted rule of giving the mercurials in the early stage and the iodids in the later will be generally followed. The experience of the writer has shown, however, the greater value of the so-called "mixed treatment" in almost all stages of the disease. The fresh solution of a combination of corrosive sublimate, gr. $\frac{1}{12}$, and iodid of potassium, gr. x, has given quicker and better results than the use of the same drugs in pill form, as biniodid or protiodid of mercury. In addition, when it is necessary to check ulcerative action or to promote the absorption of gummatous infiltration, the iodids must be given in larger and increasing doses. Occasionally a course of mercurial inunction will develop the power of the iodids when the response to treatment is not satisfactory. In all cases where there has been a development of syphilitic anemia a course of tonics will be indicated; and we should have decided benefit from the use of iron, manganese, strychnia, and cod-liver oil.

The local treatment, although secondary, will be essential in most cases of nasal and throat syphilis. The thorough cleansing of the surface by means of the spray or syringe, using an antiseptic and alkaline solution, will favor resolution and will prepare the way for the proper application of such local remedies as may be indicated. In nasal syphilis such local treatment is all-important. The dead bone should be removed, if this can be done without violence, and the ulceration touched with nitrate of silver. In the pharynx and larynx the application of compound solution of iodin will hasten the resolution of the gummatous infiltration ; and acid nitrate of mercury or nitrate of silver will tend to bring about the healing of the ulceration. In ulcers of the larynx the insufflation of aristol or iodoform with morphia will be grateful and useful. The cicatricial contractions, with the resulting stenosis in both the pharynx and the larynx, will be troublesome and obstinate. The results of surgical treatment of these conditions have been most unsatisfactory—division of the adhesions and membranous formations by either the knife or the cautery being almost always followed by a re-growth of the divided structures. Gradual dilatation has given the best results. No surgical interference is justifiable until the disease has become quiescent.

NEOPLASMS OF THE UPPER AIR-PASSAGES.

By JONATHAN WRIGHT, M. D.,

OF BROOKLYN, N. Y.

As introductory to the subject, I translate from the interesting and valuable work of Prof. Moritz Schmidt, the initial page of his chapter on "New Growths of the Upper Air-Passages:"

"In order to give some idea of the frequency of neoplasms in the upper air-passages, I will make a résumé of those observed by me in the last ten years. These occurred among a total number of 32,997 patients, and were as follows:

In the nose:

a. Mucous polypi, 757 (462 men; 295 women).
b. Fibroma, 2 (men).
c. Papilloma, 6 (3 men; 3 women).
d. Lymphoma, 2 (women).
e. Lympho-sarcoma, 2 (women).
f. Cyst, 1 (man).
g. Sarcoma, 6 (1 man; 5 women).
h. Carcinoma, 5 (3 men; 2 women).

In the naso-pharynx:

a. Fibroma, 13 (7 men; 6 women).
b. Cysts, 101 (60 men; 41 women).
c. Angio-sarcoma, 1 (man).
d. Sarcoma, 1 (man).

In the oro-pharynx:

a. Fibroma, 3 (1 man; 2 women).
b. Papilloma, 40 (29 men; 11 women). In reality the figures should be higher, since from the slight interest in these growths, careful account of them was not kept.
c. Cyst, 1 (man).
d. Tonsillar polypi, 5 (3 men; 2 women).
e. Sarcoma, 2 (1 man; 1 woman).
f. Carcinoma, 16 (15 men; 1 woman).

In the larynx:

a. Fibroma, 256 (178 men; 78 women).
b. Papilloma, 46 (31 men; 15 women).
c. Singers' nodes, 109 (56 men; 53 women).
d. Lipoma, 1 (man).
e. Myxoma, 3 (men). In recent years they are not especially mentioned. Weigert regards them as edematous fibrous polypi. They are included under (*a*).
f. Fibro-myxoma, 1 (man).
g. Tubercular tumors, 36 (14 men; 22 women).
h. Cyst, 8 (2 men; 6 women).
i. Sarcoma, 3 (men).
k. Carcinoma, 75 (61 men; 14 women).

In the trachea:

a. Carcinoma, 2 (1 man; 1 woman)."

NASAL NEOPLASMS.

Neoplasms of the nose and throat, of inflammatory origin, are met with very frequently. At a glance it may be seen in Schmidt's tables how markedly the mucous polypi preponderate over all other nasal growths. The same may be observed in the larynx, under the heads of fibroma and singers' nodes. True tumors, especially those of benign origin, are excessively rare. Much confusion has arisen from the mistaken conceptions of laryngologists in regard to the pathological character of these growths. Much of this has resulted from the exceedingly unsatisfactory theories of the pathogenesis of tumors in general. It is doubtless true that there are many neoplasms which to all histological appearances are true tumors, which yet depend on the over-nutrition of inflammatory processes for their origin. It is not the province of the writer to attempt here the task of drawing a satisfactory line of division between true tumors and the neoplasms of inflammation.

Edematous polypi of the nasal mucous membrane belong to the latter category. They are usually called myxomata, which in some degree they resemble, both microscopically and macroscopically; but they are in the vast majority of the cases, in the nose, the result of a chronic inflammation; and hence, serous infiltration being their most marked characteristic, they are better called edematous polypi. It should be remembered that the word polypus refers simply to their pedunculated form. Exactly the same histological condition is found in the nasal mucous membrane in a sessile form.

Histology.—The epithelium resembles that of the surrounding mucous membrane—*i. e.*, columnar ciliated cells in the upper part of the nasal chambers and non-ciliated below; flat cells in the lower pharynx and larynx. This epithelium may undergo metamorphoses from the attrition of surfaces or other irritation, such as the flowing of pus from the ethmoidal sinuses, so that the cilia may be lost from the columnar cells and the latter become more or less flattened, resembling the squamous type. The layers may become thickened either uniformly or digitations may form, dipping into the stroma at irregular intervals. The epithelium may, on the other hand, be entirely unchanged.

The stroma is separated by the effused serum into bundles, leaving spaces between. The size of these spaces or meshes and the quantity of the stroma-fibers differ greatly—apparently according to the degree and the age of the process.

The fluid contains some mucin and fibrin. When coagulated in the hardening processes of histological technic, the fibrin, unless broken up into granules, may be easily mistaken for connective-tissue fibers. Round cells of varying diameters are entangled in the meshes of the stroma and in the fibrin. These and connective tissue are found most abundantly in the region of the blood-vessels (Fig. 623) and glands, if they exist.

Glands are usually scanty. If present at all, they are usually found in or near the pedicle. From being barely visible, they are frequently dilated so as to form cysts of a size occupying almost the whole of a large pedunculated polypus (Fig. 624). They are found also in the sessile forms.

Blood-vessels are also scanty and capillary in size, being found most abundantly just under the epithelium, forming a delicate red tracery visible to the naked eye.

Nerves have been demonstrated in the stroma.

The pedicle, when it exists, is made up of the firmer unseparated stroma of the mucous membrane.

Etiology.—The so-called "polypoid degeneration," although histologically the same, is more conveniently considered under the head of chronic rhinitis, where, indeed, both forms pathologically belong.

Both forms are the result of chronic inflammation of the nasal mucosa. There may or may not have been previous symptoms of this rhinitis, but evidently the effusion of serum into the tissues is caused by some vascular change which is as yet imperfectly understood. We may conjecture from anatomical reasons,[1] which it is not necessary to detail here, that there is some interference with the efferent blood-current as well as with the walls of the capillaries themselves. Chronic hypertrophic rhinitis rarely occurs in children; therefore these growths are more common in adults than before twenty. They have, however, been reported at all ages, and even congenital cases have been observed. They are more common in men than in women. Out of 200 cases, according to Morell Mackenzie,[2] 123 occurred in men.

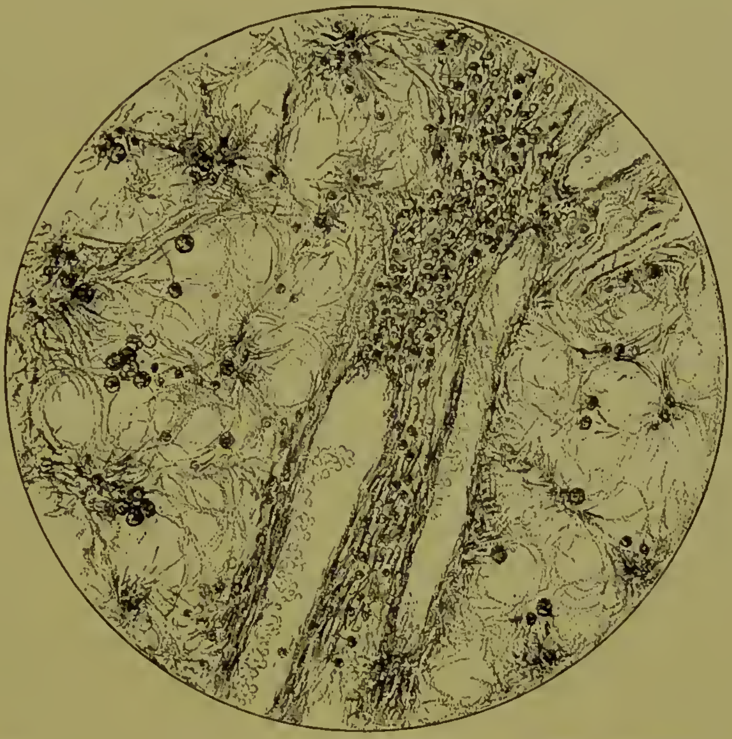

Fig. 623.—Stroma, round cells, and blood-vessels of an edematous nasal polyp.

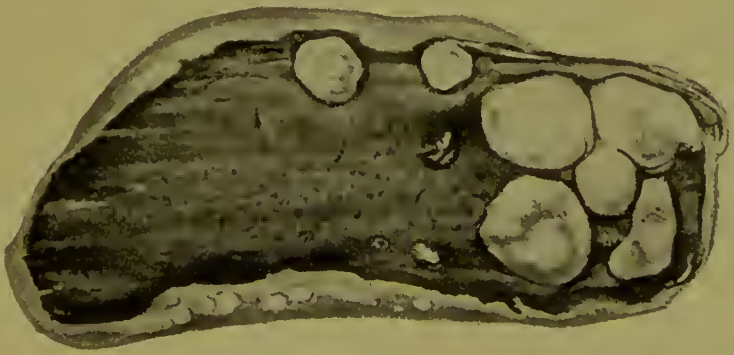

Fig. 624.—Cysts in a polyp.

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[1] "A Consideration of the Vascular Mechanism of the Nasal Mucous Membrane," etc., *Amer. Journ. Med. Sci.*, May, 1895.

[2] *Diseases of the Throat and Nose.*

Situation.—A nasal edematous polypus has its origin in the vast majority of cases from the mucous membrane covering the middle turbinated bone or from that part of the ethmoid near the hiatus semilunaris. Edematous polypi may be found, however, at any point within the nasal chambers. At the posterior end of the turbinal bodies and on the septum we usually find the sessile form combined with dilatation of blood-vessels; rarely, pedunculated growths are found in these localities. The size of the polypi varies greatly—from that of a pin's head, sprinkled over the mucous membrane of the middle turbinated bone, to enormous dimensions. I extracted one from the nostril of a man with symptoms extending over twenty years, which presented externally and projected posteriorly into the pharynx. It had filled one nostril completely, and had pushed the cartilaginous and bony septum so far to the other side as to cause complete occlusion. It was folded on itself, so that when it lay straightened out on the table it measured nearly 5 inches in its long diameter, and in some places was more than 1½ inches thick. Its pedicle was comparatively small. The pressure which it had exerted had resulted in the atrophy of the internal structures of the nose to such an extent that the enormous cavity left after extraction had smooth walls. I can find no record of any as large as this; but several have been reported that approximated it in proportions. They rarely exist separately, but when complete nasal obstruction exists there are usually multiple growths. Occasionally they fill the ethmoid cells, causing absorption of their bony walls, and once or twice I have seen distortion of the bridge of the nose. The edematous process, by pressure or the extension of the inflammation, frequently causes caries or disintegration of the ethmoidal bony tissues, and this has been called by Woakes[1] "necrosing ethmoiditis." On this account the masses removed frequently have spiculæ of bone embedded in them. The bone has been described by some writers as newly formed. This is probably a mistake.

Symptoms.—These depend largely upon the size and number of the polypi and the extent of the edematous process. Nasal obstruction may be complete on both sides, giving rise to great discomfort, or one or more polypi may exist in the nose for years without signs. A flapping valve-like action on respiratory efforts may be appreciated by the patient or even heard by the examiner.

Headaches are very common, and this is especially the case when the polypi have their bases of attachment high up, or if they invade the accessory sinuses.

A watery discharge from the nose frequently exists, causing excoriation of the margins of the nostrils and redness of the skin of the nose. This may be accentuated to an erysipelatous flush over the nasal regions.

Various complications—ethmoiditis, frontal, maxillary, or sphenoidal sinus-troubles—may be present; the patient frequently suffers from catarrhal deafness. All symptoms are aggravated by cold, damp weather.

Examination shows masses of varying extent blocking the nasal chambers or hanging down from above. They have the appearance of the pulp of a grape, and are frequently traversed by a delicate tracery of red capillaries. The color may be pink or of a dusky-red hue. Rarely, in large nasal chambers, the attachments may be seen along the borders of the middle turbinal, but usually the masses themselves preclude any attempts at inspection of the upper region of the nose, and it is impossible in the majority of cases even to ascertain with a probe the exact point of insertion. There may be great tenderness, but usually the fossæ are tolerant of examination. With a rhinoscopic mirror the masses may be seen projecting into the naso-pharynx. They may be confined to one side, but usually exist to an unequal degree on both.

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[1] *Nasal Polypus.*

Treatment.—Modern rhinology has practically abandoned all methods of removal but that by the nasal snare.

It is frequently desirable, and occasionally possible, to remove the anterior end or lower border of the middle turbinated bone in order more surely to reach their place of origin. This has been especially urged by Dr. Casselberry,[1] who has devised an instrument for that purpose. Various other instruments have been used, such as rongeur forceps, snares, drills and trephines. It is an operation which the writer has frequently found impossible to do satisfactorily. When disease of the ethmoid cells and of the middle turbinated bone coexist with the polypi, as happens in a large proportion of cases, it is well to remove as much of the bony walls as can be included in the snare or nipped off with rongeurs, care being taken not to encroach upon structures lying too close to the cribriform plate of the ethmoid. When, however, extensive bone-involvement coexists, the treatment of that becomes the chief aim and the extraction of polypi merely incidental.

It is said that edematous polypi tend to recur. When a polypus is severed at its base, it is doubtful if another appears in the same locality. When the middle of the mass is cut through by the wire, that portion left behind will sometimes shrivel up, but usually it will grow again to nearly its former size. Apparent recurrence comes from the pathological fact that large areas of mucous membrane in the middle meatus are edematous and send forth new buds and projections as fast as room is made below for them. An attempt should therefore always be made to curette this surface or cauterize it thoroughly. The cautery, however, should never be used unless a view can be had of the field of operation. Most frequently the bases of these growths are out of sight. The curette in skilful hands is then of service. As may be readily understood, no certain assurance can ever be given after any operation or series of operations, however thorough, that further polypi may not subsequently develop; and the patient should be cautioned to present himself after a lapse of several months for a careful inspection of the nasal chambers. Not infrequently it will then be seen that recurrence has not taken place, but that more or less atrophy of the mucosa has supervened. The question of the degeneration of nasal polypi into sarcoma has been much discussed. It is impossible to deny that this does sometimes take place, but many of the cases so reported are open to well-grounded suspicion of having been sarcomatous from the first, as many malignant growths present an edematous appearance.

Vascular Neoplasms of the Septum.—These are very frequently called angiomata, but they usually have exactly the same structure as do the hypertrophies of the posterior border of the inferior turbinal bodies, and are evidently dilatations of new and old blood-vessels in the mucous membrane of this locality. Many cases reported as angiomata are apparently sarcomatous or fibromatous growths, in which vascular dilatation is a marked feature. This is especially true of growths occurring elsewhere than on the septum or in the erectile tissue of the turbinal bodies. Such are many of the growths reported in Roe's tables, in the *Transactions of the American Laryngological Association*, 1885.

In the *Archiv für Laryngologie*, Bd. 1, there is a symposium of reports of vascular tumors of the septum: 13 were reported, and 5 cases may be selected from Roe's tables as undoubtedly benign vascular neoplasms; I have sections of 2 other growths, making altogether 20.

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[1] *Trans. Amer. Laryng. Assn.*, 1894.

Some of these doubtless are true angiomata—*i. e.*, made up of newly formed and dilated vascular channels; but it is impossible to separate them from the vascular growths which are entirely made up of an hypertrophy of one or more of the elements of the normal mucous membrane combined with marked vascular changes. The fibrous elements may predominate or the lymphoid layer may be greatly proliferated; but more frequently there is an unequal and irregular increase of all the elements of the mucous membrane. The surface-epithelium is usually proliferated, and frequently the cells are altered in shape. In other words, marked vascularity is a characteristic of all septal neoplasms.

Growths of similar structure in the erectile tissue of the turbinal bodies—the "turbinal varix" of English writers—will not be considered here, as they are usually included under the head of hypertrophic rhinitis.

Symptoms.—Nasal obstruction on the affected side may have existed for many years. Hemorrhage from the nostril frequently occurs, and may be dangerously abundant. The growth does not erode the neighboring tissues, although it may completely fill the lumen of the naris. Some of the cases reported have been of rapid growth, and yet apparently benign.

Examination shows a rounded growth with a somewhat irregular surface of a bright-red or dark-purple appearance. It may be abraded in places, and when probed bleed easily. It is more or less movable, according to its size and the thickness of its pedicle. It is usually attached to the anterior part of the septum.

Prognosis.—If the growth is shown to have no malignant elements, the prognosis is good. Removal is comparatively easy, and recurrence is very exceptional.

Treatment.—The galvano-cautery snare, armed with an irido-platinum-wire loop, is the instrument of choice. Jarvis's original snare may be used and the steel-wire loop slowly tightened, sometimes using several hours in the process. A rapid cutting-operation is pretty sure to be followed by severe hemorrhage, and this may occur after any operation with the wire, however slow. For slight oozing the galvano-cautery is sometimes efficacious. Firm packing with strips of iodoform or borated gauze should be employed in obstinate cases, and pressure exerted against the ala from the outside, since the site of the growth is usually far enough forward for this simple procedure to avail.

Fibroma.—While it occasionally occurs in and about the naso-pharynx, fibroma springing from the nasal structures is exceedingly rare.

One reported by Dr. Charles H. Knight[1] I had the privilege of examining microscopically (Fig. 625). It was a smooth movable growth, attached to the posterior end of the middle turbinal body, and was darker in color than the average edematous polyp. Microscopically it was seen to be covered by columnar epithelium, and was made up exclusively of homogeneous bundles of curling elastic fibers. Its removal by the cold snare was easily performed and produced no hemorrhage. There was no recurrence. A number of cases have been collected from literature by Bosworth,[2] Casselberry and others; but a perusal of the reports leaves one in considerable doubt as to the accuracy of the histological diagnosis or of their intranasal origin. Even the case referred to here as of undoubted histological character and springing from an intranasal structure, might be more conveniently considered under the heading of naso-pharyngeal growths.[1]

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[1] *Manhattan Hospital Reports*, Jan., 1895.

[2] Bosworth: *Dis. of Nose and Throat.*

Fibroma Papillare or Papilloma.—Ten or a dozen undoubted cases, and probably a few more, have been reported, but some confusion exists as to their identity; the same name having been given by Hopman[2] and many of the Germans to the papillary hypertrophies of the nasal mucous membrane, which occur so frequently in the regions of erectile cavernous tissue. True papilloma is made up of epithelial cells supported by a delicate framework of new connective tissue, rising on the surface as papillæ and dipping into the underlying stroma as digitations. They grow principally by the proliferation of epithelial structure. They occur in the nose, either as soft pedunculated masses or as hard warts on the anterior portions of the septum. The soft growths also occur on the floor of the nose and on the anterior portions of the external wall. So constantly is this the rule in those cases which have been examined and properly classified, that any papillary growth seen to be springing from other localities or reported without microscopical proof as having been found elsewhere in the nose, may be regarded as probably not a papillary fibroma. Exactly such a growth as figured in Zuckerkandl's "Anatomy of the Nasal Fossæ"—springing from the middle of the under surface of the inferior turbinal—I once examined and found to be a papillary hypertrophy.[3]

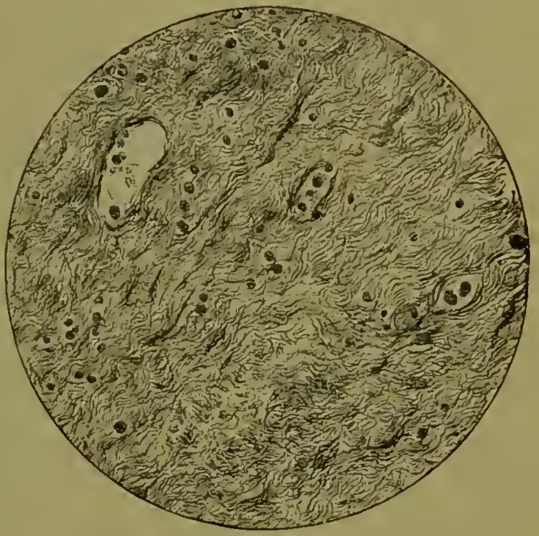

Fig. 625.—C. H. Knight's case of nasal fibroma.

True papillomata of the septum have been observed at all ages. I have examined one for Dr. Arrowsmith of Brooklyn coming from the nasal fossa of a child of five, and Santi has reported one in a man of eighty-four. Sex seems to have no influence.

They are usually of slow growth and painless, but sometimes bleed easily. They cause nasal obstruction and have a valve-like action on the respired air, as in the case of the ordinary polyp. They have a vascular fungous look and are freely movable. Hemorrhage on removal may be abundant, but is easily controlled. They do not tend to recur.

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[1] Bosworth, by saying that all naso-pharyngeal fibromata spring from the basilar process of the occipital or the body of the sphenoid bone, excludes all of those whose origin is in the immediate vicinity, just within the choanæ. These he evidently includes among the nasal growths, since he refers to 41 cases in literature, most of which seem to have had all the characteristics of the naso-pharyngeal growth and some probably sprang in reality from behind the choanæ, forming secondary attachments within the nose. Mackenzie, on the other hand, gives a more liberal interpretation to the term naso-pharyngeal fibroma, and includes those which spring from the immediate vicinity of the naso-pharynx and present the same or nearly the same clinical features. Thus it comes that he is able to report but one case of his own of nasal fibroma and to refer to very few in literature. The case of Dr. Knight sprang from the posterior end of the middle turbinal body and projected into the naso-pharynx. So that nearly all true fibromata have their origin on or in the immediate vicinity of the roof of the naso-pharynx; and absolutely none occur in the anterior part of the nasal fossæ. This is exactly what we should expect, when we remember that the fibrous sheet at the roof of the pharynx spreads out laterally upon the pterygoid plates, and anteriorly for some little distance along the roof of the nose, and on the vomer and posterior surfaces of the upper turbinated bones.

[2] Virchow's *Archiv*, 93, 1883, p. 213.

[3] *N. Y. Med. Journal*, Oct. 13, 1894 (Dr. Richard's case).

The following references will be found to include nearly all the reports of true papillomata up to August, 1896, though some of these are of doubtful character:

Michel: *Krankheiten der Nasenhöhle* (Translated by Shurly, p. 72).
Zuckerkandl: *Anatomie der Nasenhöhle*, 1882, p. 70.
Aysaguer: *Annales des Maladies de l'Oreille*, Nov. 1885, p. 335.
Butlin: *St. Bartholomew's Hospital Reports*, 1885, p. 150.
Verneuil: *Bull. et Men. de la Société de Chirurgie de Paris*, No. 12, 1886, p. 658.
Solis-Cohen: *Revue de Laryngologie*, 1889, p. 151.
Cozzolino: *Revista Clinica et Terapeutica*, No. 2, Feb., 1887, p. 75.
Mulhall: *Trans. Amer. Laryng. Assn.*, 1890.
Santi: *The Lancet*, Dec. 8, 1894.
Wright: *Trans. Amer. Laryng. Assn.*, 1895.
Mackenzie (G. Hunter): *Lancet*, Aug. 15, 1896.

Treatment.—Removal by the snare can usually be accomplished without much hemorrhage. As the growths are situated in the anterior part of the nose, bleeding, if it occurs, may be easily controlled.

Bony cysts of the nose are of moderately rare occurrence. They are found in the anterior end of the middle turbinated bone, and may contain only air or a yellow viscid fluid or pus.

Pathology.—The middle turbinated bone is considerably enlarged anteriorly, and is covered by hypertrophied and usually edematous mucous membrane. Edematous polypi are frequent complications.

Microscopical examination of the bony wall must be made after decalcification. Sections are then cut, and it will be seen that the cyst-cavity, which may be as large as a cherry, is lined by a scanty stroma without glands or many blood-vessels and by columnar ciliated epithelium. The bony tissue itself is seen to be in a condition of hyperplastic and rarefying inflammation, with the formation of new bone-tissue and the absorption of old and new bone. This is carried on by means of osteoblasts and osteoclasts and the formation of Howship lacunæ. There are lakes, or rather gulfs and bays, of new connective tissue, which nourish the peculiar cuboidal cells which line their shore, and which have the power of secreting and

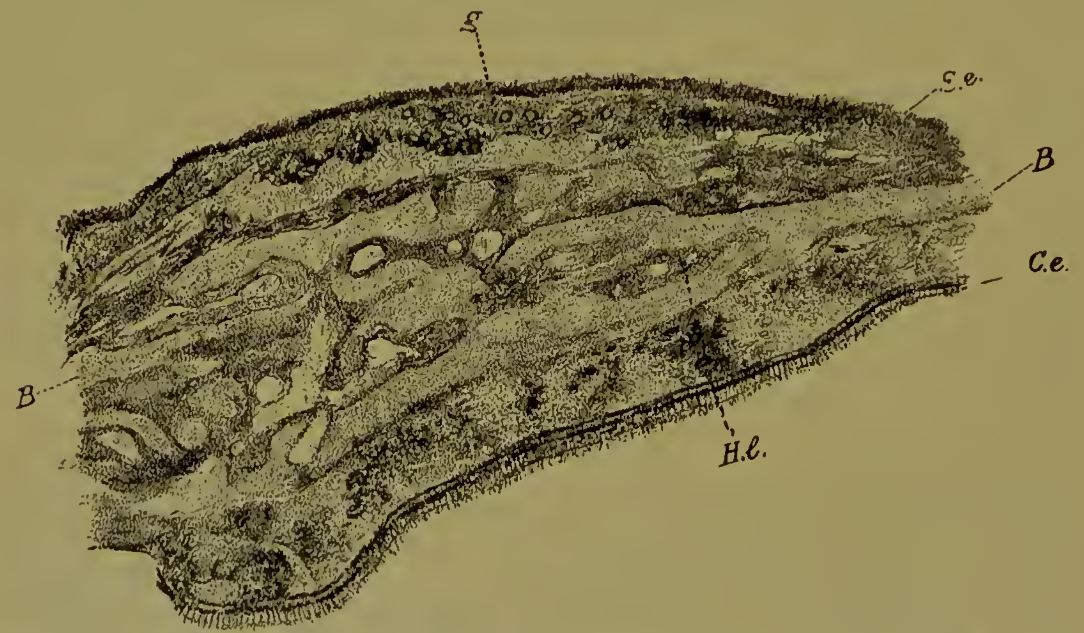

FIG. 626.—Section of bony cyst: *B*, bone; *Hl*, Howship's lacunæ with new connective tissue and blood-vessels; *Ce*, ciliated epithelial lining of cyst-cavity; *Se*, surface epithelium; *g*, glands.

absorbing bone-salts. Figs. 626, 627, from a section of a specimen sent me by Dr. Butts of New York City, show this process, which is essentially the same as the physiological process of bone-growth.

Occurrence.—The condition is almost wholly confined to women after puberty and before old age. We see here, as well as in atrophic rhinitis and naso-pharyngeal fibroma, the marked influence of sex on morbid processes in the nose. I am not aware that these cysts have been reported as existing in any other locality in the nose than at the anterior end of the middle turbinated bone.

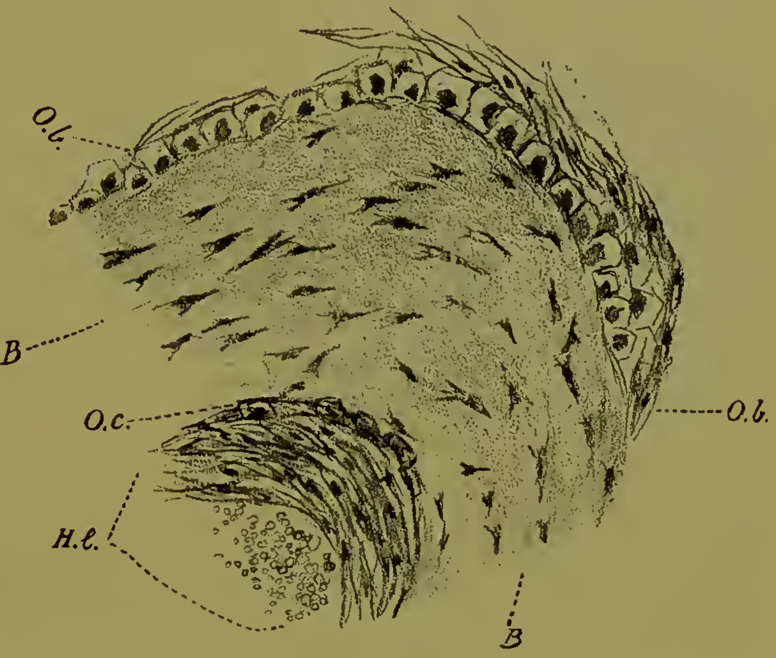

FIG. 627.—Section of bony wall of cyst, showing a Howship lacuna with its marginal osteoclasts (*O c*) below, and the osteoblasts (*O b*) on the convexity of the bony lamella.

Symptoms.—Pain with frequent exacerbations is the prominent symptom in these cases. Nasal obstruction also exists, but may not be complete: at times it is the only symptom present. As the patient nearly always has edematous polypi in the same nostril, the symptoms depend somewhat on that condition. These symptoms have usually extended over many years.

Examination after removal of projecting polypi shows a rounded resisting mass at the anterior end of the middle turbinated bone, a part of which it forms, pressing firmly against the septum and sometimes causing a marked deviation of it. The feeling imparted to a probe conclusively shows that the mass is made up of bone.

Etiology.—From what has preceded, the inference is pretty clear that we have here a pathological condition which is the result of chronic inflammation. This, beginning in the mucosa, results in the formation of edematous polypi, as explained under that heading. The inflammatory process is in time transmitted to the underlying periosteum and bone, and we have then the condition of hypernutrition which causes the growth of the bony structure. This we should expect to result in the porous formation observed in other hyperplastic bone-processes, and this we frequently see in dried specimens of the middle turbinated. Since there is mucous membrane lining the walls of these cysts provided with columnar ciliated epithelium, we must presume that communication has existed at some time with the external surface. The demonstration of the proliferative bone-formation in the walls of these cysts shows pretty clearly the method of development into large spaces of what were originally small cavities. Their communication with the ethmoidal labyrinth may have closed before the end of embryonic development, or it may have existed prior to inflammatory changes and have been closed by them, or the communication may still exist. Dr. T. Passmore Berens of New York was kind enough to show me a dry specimen of cystic enlargement of the anterior end of the middle turbinated bone, in which the communication was wide and direct.

Treatment.—The steel-wire snare may be used to remove these bony outgrowths. If they are too resistant or too firmly wedged against the septum to allow the use of this instrument, a perforation may be made into the cavity with a dental burr or trephine and the bony walls then removed piecemeal with rongeur forceps. Hemorrhage may be considerable, and there may be considerable inflammatory reaction. When, as frequently happens, there are carious bone and edematous polypi, curetting must also be employed.

LITERATURE OF BONY CYSTS OF THE NOSE.

Zuckerkandl: *Norm. and Path. Anatomie der Nasenhöhle*, 1893, vol. i. p. 63.
Stieda: "Inaug. Dissertation," Rostock, 1895.
Glasmacher: *Berlin. klin. Woch.*, No. 36.
Beyer: *Internat. Centralb. f. Laryngologie*, etc., vol. ii., No. 5, p. 237.
Schaffer: *Erfahrungen in der Rhin. und Laryng.*, Wiesbaden, 1885.
McBride: "Diseases of Throat, Nose, and Ear," original report, *Edinburgh Med. Journ.*, Dec., 1888, p. 304.
Schmiegelow: *Revue de Laryngologie*, etc., No. 10, 1890.
B. Fränkel: *Berl. klin. Woch.*, No. 22, p. 498, 1890.
P. Hegeman: *Ibid.*
Chas. H. Knight: *Trans. Amer. Laryng. Assn.*, 1891; *N. Y. Med. Journ.*, Mar. 19, 1892.
Stieda: *Archiv f. Laryn. und Rhin.*, Bd. 3, No. 3, 1895.
Wagnier: *Rev. de Laryngol.*, etc., No. 22, 1895.
Castañeda: *Archivos Latinos de Rinologia*, Sept. and Oct., 1895.
Macdonald: *Lancet*, June 20, 1891.
Zwillinger: *Wiener klin. Woch.*, No. 19, 1891.
Wright: *N. Y. Medical Journal*, June 27, 1896.

Cysts of the nasal mucous membrane, sometimes called **cystomata,** are occasionally reported. They are always, I believe, of glandular origin, resulting from the excessive dilatation of glands in edematous polypi or tissue.

Osteoma and **chondroma** have both been reported as new growths in the nose. They are of exceeding rarity, and are not to be confounded with the very common exostoses and ecchondroses of the septum.

As has been intimated, true tumors—*i. e.*, circumscribed neoplasms not due to inflammation—are rare in the nose, and in my experience such benign tumors are much more rare than malignant growths. It is exceedingly difficult, however, to gain any idea of this from rhinological literature, as all sorts of inflammatory phenomena are classified as tumors. The writer does not speak of true myxoma of the nose, because out of many hundred sections of 50 or 60 specimens of mucous polypi examined microscopically, and many more nasal neoplasms seen and operated on clinically, he has never observed a nasal growth that was plainly a true myxoma. There is hardly a case reported in literature, in which the diagnosis is not open to grave criticism from the data given or from insufficiency of data. Nevertheless, it is probable that such true tumors do occasionally grow in the nose.

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MALIGNANT TUMORS OF THE NOSE.

Adenoma is said to be a benign growth; but it is so frequently combined with carcinomatous or sarcomatous elements, and it is said, even when pure, to degenerate so frequently into malignancy, that its occurrence in any structure is to be looked upon with suspicion as to its benign character. Pure adenoma (Fig. 628) in the nose is almost unknown, although hypertrophy of the glandular structures of the mucosa is occasionally seen carried to such an extent that the question of its inflammatory origin may well be raised. A typical adenoma is made up of epithelial cells so arranged as to form convolutions and tubules more or less resembling gland-structure. Indeed, it usually springs from the glandular cells of various organs. There is very scanty connective tissue, round cells, and blood-vessels. I have in my possession sections of a nasal tumor, in portions of which, at least, pure adenomatous structure may be observed. The case was under the care of Dr. Thomas J. Harris, at the Manhattan Eye and Ear Hospital, and to him I am indebted for the following history:

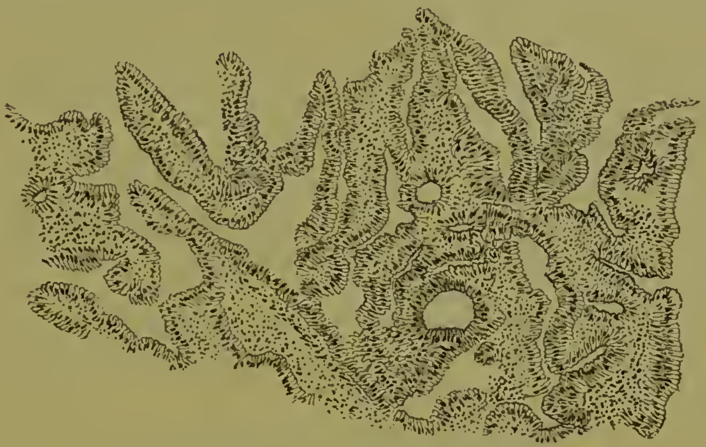

FIG. 628.—Adenoma of the nose.

> "The patient, Mr. C., is seventy-five years old, and has been under my care some eighteen months. When he first came to the hospital in November, 1893, he was a most pitiful object. There was total occlusion of the nares, with muco-pus constantly dripping from them. They were filled with masses of tumors presenting all the appearances of the common gelatinous polypi. By snare and curette in a number of operations I removed everything, making a diagnosis (from repeated recurrences) of myxosarcoma. For nearly a year, with occasional gentle curetting, the nares remained clear. His appetite returned and he pronounced himself cured. In November, 1894, exophthalmos (left eye) appeared with constant pain. I then supposed that the ethmoid sinuses had been invaded, but on account of his age determined to attempt no operation. The nose still remained comparatively free. Some two weeks ago the mass which I sent you suddenly appeared. This I removed with the cold snare, and considerable hemorrhage followed. The macroscopical appearances of the tissue had long since changed, and it now shows much necrosis. Its malignancy has certainly very much increased in the eighteen months in which I have observed the case."

This patient, Dr. Harris informed me, lived until the following summer (1895). The greater part of the sections of the mass were taken up with convolutions and involutions of glandular epithelium. The layers of epithelium were never more than two or three deep, and were supported by a framework of new connective tissue.

In the portion of the growth sent me, from which the section shown in Fig. 628 was made, I am unable to find any plainly sarcomatous tissue; but there are extensive areas of round and spindle-cells which, although they more closely resemble the granulation-tissue of inflammation, may be of a sarcomatous nature. Moreover, the clinical history plainly shows that the growth, at least in its later stages, was of a malignant character. By a coincidence, such as so strangely and so often occurs in clinical work, a similar instance of an adenoma—this time, however, plainly showing sarcomatous tissue—came under Dr. Harris's observation shortly after the first case.

Dr. Bosworth says that he has been able to find in literature the reports of only a very few cases, and even in these there is a reasonable doubt as to the unmixed character of the growth. Not only does it have on the one hand a puzzling resemblance and a close relation to glandular hypertrophy, but, on the other hand, it is frequently combined with epitheliomatous appearances—the so-called tubular or adeno-carcinoma.

Papillary Epithelioma (Zottenkrebs).—Closely allied to adenoma, if not identical with it, is a rare nasal growth which Billroth,[1] who reported 2 cases, called "Zottenkrebs." Michel,[2] Hopman,[3] Zarniko,[4] and Kieselbach[5] have each reported a case.

The last named called it a papillary epithelioma. It is a benign growth, as a rule, and resembles a papilloma. In Fig. 629 will be seen the drawing of a slide sent me by Dr. Hinkel of Buffalo. It came from a tumor which occurred on the middle turbinal of a woman. It will be seen that it is made up of convolutions and involutions of columnar epithelium supported by a framework of fibrous tissue infiltrated with round cells. It forms a villous surface like a papilloma, but differs from it in that the layers of epithelial cells are not thickened and do not dip into the stroma. There is no infiltration of tissues nor concentric epithelial nest-formation in the tissues, as in cancer. In one of Billroth's cases it had existed for eleven years, and in Kieselbach's case he had removed successive portions of the growth for a period of six years. In the cases of Zarniko, Kieselbach, and Hinkel[6] it has been reported as occurring on the middle turbinal. In Zarniko's case it was combined with edematous growths.

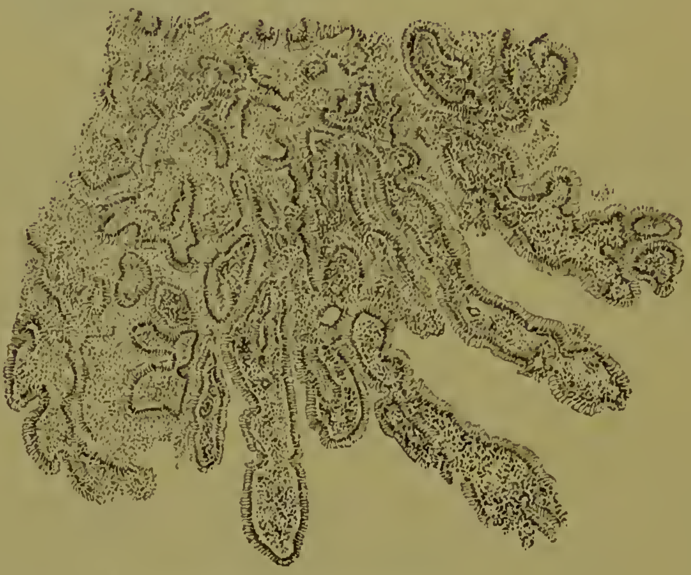

FIG. 629.—Papillary epithelioma of the nose.

From the history of Verneuil's case, which I have placed among the papillomata because it was so reported, we may conjecture that it was possibly also of this nature. Otherwise it is a unique case of papilloma.

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[1] *Ueber den Bau der Schleimpolyp.*

[2] *Die Krankheiten der Nasenhöhle,* etc.

[3] Virchow's *Archiv,* Bd. 93, p. 234.

[4] Virchow's *Archiv,* Bd. 128, p. 132.

[5] Virchow's *Archiv,* Bd. 132, p. 371.

[6] Hinkel, *Trans. Amer. Laryng. Assn.,* 1898.

Sarcoma, in my experience, is the most common tumor of the nasal fossæ, if we exclude those benign neoplasms which are the result of the various forms of chronic inflammation or directly connected with them. This, however, I am aware, does not coincide with the statements of those who have had larger experience and perhaps wider fields of observation. The discrepancy, as intimated above, is evidently, however, one of pathological nomenclature.

This is not the place for an extended description of the histology of sarcoma, which in the nose presents no characteristics to distinguish it from sarcoma elsewhere in the body. Dr. Bosworth[1] has given abstracts of the histories of 41 patients with sarcoma of the nose.

Newman, in his excellent monograph on "Malignant Disease of the Nose and Throat," gives the history of 3 cases of sarcoma and 2 of carcinoma of the nose, as well as a complete bibliography of the subject. His table of ages at which sarcoma occurs is given as follows:

Below 10 years	6	per cent.
10 to 20	19	"
20 " 30	8	"
30 " 40	9	"
40 " 50	39	"
50 " 60	8	"
60 " 70	9	"
Above 70	2	"

I have in my collection microscopical sections of two specimens sent me by Dr. Thomas J. Harris of New York—one of adeno-sarcoma, the other of angio-sarcoma (Fig. 631), also a specimen of endothelial sarcoma (Fig. 630), from Dr. F. W. Hopkins of Springfield, Mass., and one of alveolar sarcoma, from Dr. W. P. Brandegee of New York. Gouguenheim and Hilary,[2] Dansac,[3] and Katzenstein[4] have reported 5 others. This makes 53 cases in all, from which certain facts are apparent.

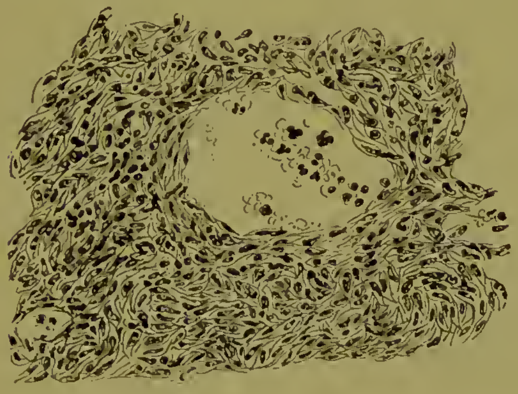

FIG. 630.—Endothelial sarcoma of the septum.

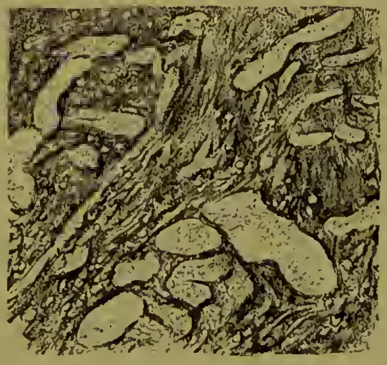

FIG. 631.—Angio-sarcoma of the septum.

It is difficult to ascertain what form of sarcoma has been most frequently observed in the nose, as the nomenclature in the reports varies so. All forms seem to have been noted, the round-celled variety perhaps more frequently.

As to age, 15 of them were between forty and fifty, 11 were over fifty, and 17 were under forty years of age. Of those in whom sex was mentioned, 29 were women, 24 were men. The right side of the nose was affected 15 times and the left side 9 times.

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[1] *Diseases of the Nose and Throat.*

[2] *Annales des Maladies de l' Oreille*, 1893.

[3] *Ibid.*, 1893.

[4] *Ibid.*, 1891.

Etiology.—This is entirely unknown. Too many people have chronic rhinitis to permit us to state that nasal catarrh is a predisposing factor. Injury is too infrequent an incident in the clinical history to allow us to look on it as an exciting cause. It occurs most frequently in middle life, when, as a rule, over-nutrition of cell-life has ceased and before degeneration-changes have set in.

It may be well again to say that convincing evidence of sarcomatous degeneration in benign tumors or in inflammatory neoplasms of the nose is lacking. None of the cases of such asserted malignant transformation are free from the reproach of insufficient observation or incomplete examination. Surface appearances and the early clinical history are not criteria of histological structure. The possibility of such transformation, however, cannot be denied.

Symptoms.—Unremittent and increasing unilateral nasal obstruction, accompanied often by repeated epistaxis, is the initial sign of malignant nasal disease. The patient soon complains of pain, referred to the brow or temple. At first a watery, then a sanious muco-purulent, discharge comes from one or both nostrils. Photophobia and epiphora on the affected side are usually present, and there may be affection of the vision from pressure on the optic nerve. The general health is at first but slightly affected. As the tumor grows, pain and loss of appetite, sleepless nights, frequent epistaxis, the nauseous odor and the mental distress cause rapid loss of strength and flesh, making an unmistakable picture of human misery. Exophthalmos, the widening of the bridge of the nose (the so-called "frog-face"), edema and discoloration of the face are the external evidences of the disease.

Examination at an early stage may reveal implantation of the growth at any point in the nasal chambers. It may be a smooth, somewhat resilient growth; but it is usually, especially in the later stages, a friable fungous mass, bleeding easily when touched. Portions of it are apt to be edematous, and it may have every appearance of the ordinary nasal polyp, but the color is apt to be darker. It is evidently more vascular, and it may not be at the usual site of origin of the ordinary polypus. The growth soon reaches such a size that it is impossible to make out its origin. The nasal cavity is filled, and it encroaches upon and fills the naso-pharynx. It may grow into the antrum. It soon projects from the nostril anteriorly. It may grow upward, absorbing the cribriform plate and causing death; or it may grow downward, pushing down the soft palate or eroding the bony nasal floor. Cervical glands at the angle of the jaw are usually not involved until a late stage of the disease, when the diagnosis is tolerably clear.

Diagnosis.—The patient usually does not present himself until it is perfectly evident that we have a malignant growth to deal with, but some cases have been reported as seen in their earliest stages. Its vascularity or its lack of transparency, its unusual implantation, its proneness to considerable hemorrhage, or its appearing as a single growth, may arouse suspicion that it is not an ordinary edematous polypus. Its prompt extirpation and microscopical examination should follow. If the microscope should reveal the appearances of a round-celled sarcoma, the clinical observer must not unreservedly accept the diagnosis, however skilled a microscopist may have made it. The vigorous administration of the iodid of potash combined with mercury may disprove the most positive assertion of the pathologist and the most careful diagnosis of the clinician. The other forms of sarcoma, however, do not so much resemble the granulation-tissue of syphilis or tuberculosis. From the vascular growths of the septum, the so-called bleeding polypi or angiomata, sarcoma is to be distinguished by its more rapid growth and by its greater friability and tendency to bleed on slight provocation. A sarcoma of the septum in its early stages may, however, closely resemble these vascular growths both in structure and general appearance.

Prognosis depends largely on the character of the elements, the situation, involvement of parts, rapidity of growth, and the promptness with which the character of the trouble is recognized and the proper treatment instituted. Mingled with fibrous, vascular, or glandular hyperplasia, prompt and thorough eradication may result in cure, or at least in indefinitely putting off recurrence. Frequent recurrences do not necessarily make the case hopeless. It should be carefully watched and new growths promptly and thoroughly removed. When situated in the upper part of the nose it may easily have involved intricate and vital structures, rendering complete removal impossible. Wherever it may be attached, no operation should be attempted that does not hold out a chance of complete removal. Any incomplete operative measures will only accelerate the growth and render the patient's doom more certain.

Treatment.[1]—When the growth is circumscribed or has a pedicle, removal by the hot or cold snare and subsequent curetting of its base may be efficient. Application of caustics, cauterization, or electrolysis should be avoided. An external operation may hold out prospects of thorough removal which internal operations do not: if so, this heroic treatment should be promptly adopted.

Carcinoma of the nose is of rare occurrence. Many of the cases referred to by Bosworth are apparently not substantiated by a microscopical diagnosis. Seifert and Kahn picture one in their histological atlas, and Dr. Beaman Douglas has lately reported one in the *N. Y. Medical Record*, Aug. 8, 1896. The symptoms do not differ materially from those of sarcoma, from which it must be diagnosticated by means of the microscope.

The **prognosis** is entirely bad. Operation does not lengthen life nor, as a rule, alleviate suffering.

TUMORS OF THE SINUSES.

Benign neoplasms of the maxillary sinus are: *Bony cysts*, which occur in connection with the roots of the teeth. *Edematous polypi*,[2] which occur occasionally as the result of purulent inflammation, but are also frequently found at autopsy, having given no sign during life.

Cysts of the mucous membrane are also seen very frequently post-mortem. Rarely they fill the whole antrum, as in a case reported by Dr. Chas. H. Knight.[3]

The suggestion was made many years ago and adopted by Virchow[4] that the cases of the so-called hydrops of the antrum of Highmore were probably of this nature. The cysts are, as in the nose, of glandular origin.

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[1] Coley's method of treatment by erysipelatous streptococcus-serum is credited with some success in otherwise hopeless selected cases, especially of spindle-celled sarcoma, wherever situated.

[2] Zuckerkandl, *Normale und Pathologische Anatomie;* Heyman, Virchow's *Archiv*, Bd. cxliii., Heft 1; Fränkel, *Archiv für Laryngologie*, Bd. iii., Heft 3; Dmochowski, *Ibid.*

[3] *Trans. Amer. Laryng. Assn.*, 1895.

[4] *Die Geschwülste*, Bd. i., p. 244.

Osteoma, apart from the very common exostoses, is occasionally noted post-mortem.

De Roaldes has reported a remarkable case of compound follicular odontoma of the antrum.[1]

Malignant Neoplasms of the Antrum.—**Sarcoma** has frequently been reported as primary in the antrum, and Schmidt makes the statement that carcinoma is not an infrequent occurrence. While I have seen several cases of sarcoma which presumably began in the antrum, I have never seen a carcinoma, and I am familiar with only one report in general literature.[2] This case is so well authenticated and the history so well reported by Dr. Reinhard,[3] that an abstract of some of the points may be useful to the rhinologist as illustrating the course of malignant disease in this locality. The patient was a man of sixty-five. For five years he had suffered from left-sided nasal obstruction, and for one year from unilateral nasal suppuration and radiating pain in the left side of the face, with loss of flesh and strength. The anterior molar tooth of the upper jaw having become carious, the patient had it removed, and this was followed by the discharge of foul-smelling pus through the alveolus into the mouth. The left side of the face became somewhat swollen, and the alveolar opening into the antrum became larger. On using a probe it was evident that it did not move freely in the antrum, but was engaged in some soft substance. Fluid syringed in the opening came out of the hiatus semilunaris much more quickly than in simple empyema of the antrum. There were no glandular enlargements and no eye-symptoms; the patient receiving no benefit from constant irrigation of the antrum, a snare was introduced through the alveolar opening and some of the tissue removed. A polyp was also removed from that side. Microscopical examination showed the antral growth to be carcinomatous, and that the nasal polyp was a hypertrophy of the nasal mucosa. On account of the severe pain, excision of the jaw and extirpation of the growth, which was more extensive than expected, was performed, with at least temporary relief from all symptoms. The patient was discharged five months later with no recurrence. A similar case has been reported by Dr. Wendell Phillips.[4] I have had the privilege of seeing the patient and examining the specimen.

This illustrates how a malignant growth may set up an empyema of the antrum, which may be taken for the sole and primary trouble. It also shows that the excision of the jaw may be indicated and successfully performed for temporary relief of the symptoms, which in this case and in all such cases are unendurable if the operation, however severe and dangerous, holds out any hope of relief. Death on the operating-table may perhaps be considered the most successful outcome for the patient.

The neoplasms of the ethmoidal sinuses may be considered as having been treated of under the head of nasal neoplasms. Nearly all the edematous polypi spring from the mucosa of this region, and they may infiltrate the ethmoidal cells to such an extent as to simulate malignant growths by causing external deformity. The malignant growths of the ethmoid are inoperable, and prove rapidly fatal by extension to the cerebral cavity.

Neoplasms of the Frontal Sinuses.—Osteomata sometimes occur in the frontal sinuses, and usually give rise to no symptoms. Schmidt[1] says that occurring in the nose they usually start from the mucosa of the frontal sinus, and the same is true of many orbital exostoses. Cysts of the mucous membrane are rare, but even dermoid cysts have been noted in the frontal sinuses and in the anterior parts of the nose.

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[1] *Trans. Amer. Laryng. Assn.*, 1894.

[2] Verneuil also reported a case of epithelioma of the left maxillary sinus in the *Bull. de la Société de Chirurgie de Paris*, 1886, p. 658.

[3] "Ein Fall Von Primaren Epithelial Carcinom der Oberkieferhöhle," *Archiv f. Laryngologie*, Bd. ii., p. 230.

[4] *Journ. of Laryngology*, July, 1898.

Edematous polypi and especially edematous swelling of the mucous membrane are found in connection with empyema of the sinus, and occasionally without pus-formation, as a complication of a similar condition in the nasal mucosa.

Sphenoid Sinus.—Similar pathological conditions as to neoplasms are reported by Zuckerkandl as having been found in the sphenoidal sinus, but the diseases of these cavities have not as yet been sufficiently studied to make a consideration of their neoplasms profitable here.

TUMORS OF THE NASO-PHARYNX.

Naso-pharyngeal Fibroma.—Naso-pharyngeal fibroma is a tumor which, in many respects, presents peculiar characteristics. It is histologically a benign growth, but owing to its situation gives rise to symptoms which, if unrelieved, are almost certain to result in death; and it demands operative treatment which the most skilled rhinologist and the most daring surgeon are sometimes unable to afford with success.

It occurs almost exclusively in males between ten and twenty-five years of age. So marked is this influence of age, that not a few cases are recorded of spontaneous recession of the growth after this period, affording in this respect a marked resemblance to another naso-pharyngeal growth—viz., lymphoid hypertrophy or adenoid vegetations.

It is fortunately tolerably rare, and it falls to the lot of very few rhinologists to have seen more than two or three instances. Situated at the base of the brain and at the junction of the air- and food-paths, almost at the center of the skull, endowed with the faculty of unlimited growth, pressing upon and absorbing even bony structure, its early recognition and its prompt and vigorous treatment are of vital importance to the patient and of great difficulty to the surgeon.

It springs from the dense fibrous tissue and periosteum which cover the under surface of the basilar process of the occipital bone and the body of the sphenoid. This fibrous tissue extends to some extent laterally down to the pterygoid plate of the sphenoid and perpendicular plate of the palate-bone, as well as on to the posterior ends of the upper turbinated bones and the vomer. From these situations, also, fibroma occasionally takes its origin. From whatever source it springs, it may contract adhesions with contiguous structures by inflammatory processes.

Histology.—Its structure is dense, being made up almost entirely of white fibrous tissue, between the fibers of which may be seen in places areas of round and spindle-cells, which remind one of sarcoma.

Etiology.—Its more or less sharp limitation to the age of adolescence and the male sex would seem to point to some connection with the cranial development, which is so marked during this period; but it is not an unknown affection in the female or before or after the period of ten to twenty-five, which includes the great majority of cases.[2]

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[1] *Die Krankheiten der Oberen Luftwege*, 1894, p. 506.

[2] See the chapters devoted to it in the works of Morell Mackenzie, Bosworth, and Greville Macdonald, and Lincoln's classical papers, *Trans. Amer. Laryn. Assn.*, 1879 and 1882; *N. Y. Med. Journ.*, May 26, 1894, p. 653.

Symptoms.—The initial symptoms are apt to be those of post-nasal catarrh, accompanied by repeated and at times grave epistaxis. The evidences of post-nasal obstruction soon supervene—the dead voice and thick speech and difficulty in respiration. Deafness, more or less marked, is present. A peculiar condition of somnolence has been noted in many cases, the patient being often overtaken by sudden and irresistible drowsiness. Possibly this may be akin in its etiology to the aprosexia from which some adenoid cases suffer. Later, pain and a muco-purulent discharge may be present. Pressure on the neighboring parts results in external deformity—the separation of the maxillary bones and the exophthalmos—producing the hideous aspect known as "frog-face." Growth downward forms a hindrance to deglutition; while occasionally, though rarely, upward growth through the foramen lacerum medium or by absorption of the bone may cause cerebral symptoms and death. According to Greville Macdonald,[1] vomiting is sometimes a distressing symptom.

Examination with the post-nasal mirror shows a smooth rounded mass of a color varying from pink to dark purple. Varicose blood-vessels may be seen on the surface. It may project into the nasal fossæ and be seen by anterior inspection. It may grow through the spheno-maxillary fissure and be felt under the zygoma. When of moderate size its base of implantation may be seen; but usually it fills the post-nasal space, and so frequently has contracted adhesions to neighboring parts that its origin cannot be distinctly made out. It usually has a broad base, but it sometimes has a small one, being pedunculated and freely movable. This may be appreciated by a probe through the nasal fossæ or by the finger behind the palate. To the finger it has a firm elastic feeling. Considerable care and gentleness must be exercised in these maneuvers, as alarming hemorrhage is apt to occur.

Diagnosis.—The chief difficulty in diagnosis is to distinguish it from sarcoma. The age and sex of the patient, the place of origin, and to some extent the firm consistence of the tumor, may serve to establish its nature; but frequently the microscope must serve as the final arbiter.

Prognosis.—Naso-pharyngeal fibroma is a grave disease at best, but it is rendered still more so when it has progressed so far as to render an external or preliminary operation necessary. Left to itself, it usually results in a suffering death; although some cases are related where spontaneous cure has taken place. When occurring near the end of the period of liability, they have been observed to retrocede and even to slough away. This, however, should never be expected or waited for if operative procedures hold out any hope of successful removal. The favorable cases are those which present themselves with a pedunculated growth, and in whom the whole naso-pharynx is not filled with it; and if I may be allowed to make the remark, their chances are considerably better if at this stage they fall into the hands of a skilled rhinologist rather than into those of a general practitioner who does not at once recognize the character and gravity of the case, or of a general surgeon who is disposed to recommend at once an external operation.

Treatment.—Several methods of procedure may be adopted. When the whole or a part of the growth can be included in the loop, the irido-platinum wire of a galvano-cautery snare should be used. Sometimes the difficulties of the technic are so great that it may be necessary to abandon this and make the attempt with the steel wire of a cold snare, occupying several hours in completing the removal. Subsequent cauterization of the stump of the growth is usually recommended, but its utility is open to some doubt. Unfortunately there are a number of cases where this operation with the snare is impossible. The shape and broad attachment of the tumor is such at times that a wire cannot be made to encircle the growth. Electrolysis should then be tried, more with the hope of diminishing the size of the mass or altering its shape to such an extent that the snare-operation is practicable. It is sometimes only possible to remove it piecemeal. Hemorrhage does not occur with the hot snare, and is not uncontrollable with the cold wire. Tamponing the post-nasal space may be necessary, and firm pressure may be made with curved instruments against the stump.

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[1] *Diseases of the Throat and Nose.*

Recurrence is frequent, and a number of operations may be necessary. If the growth can be kept in check until the period of immunity is reached, the recurrence may be finally prevented, and even retrocession in the growth may be expected. The other methods of treatment are injection of various substances into the growth. Lactic acid has been recently used by Ingals[1] with great success. The galvano-cautery electrode may also be used to advantage at times, but usually as an adjuvant to more thorough methods of removal. Finally, as a last resort, the patient may be submitted to the risk of an external operation. An operation for a naso-pharyngeal growth which cannot be removed by intranasal maneuvers is necessarily one of the gravest and most dangerous which the general surgeon can undertake; and statistics of the results both in intranasal operations and in the preliminary external operations seem to warrant the preference of the best authorities for the former, while the latter procedure should be resorted to only when all other methods have been demonstrated to be absolutely of no avail.

Fibro-mucous polypi are described by various writers as partaking partly of the character of the pure fibroma and partly of that of the edematous polypus within the nose. These growths are evidently fibromata of sluggish growth which have become edematous. Such growths usually have their origin partly, at least, within the nose. They do not bleed, nor do they tend by their pressure to invade other regions and absorb adjacent structures. They are usually pedunculated, and their removal is not attended with any great difficulties. They seem to be regarded as of rare occurrence; but it is probable that their comparatively trivial character has led to less frequent reports than of the more formidable fibromata. They are said by Bosworth to occur more frequently in females.

The **symptoms** are those of post-nasal obstruction and irritation.

Examination shows that the growth is paler in color and has a softer consistency and a smaller pedicle than the true fibroma. It is more movable.

Treatment is correspondingly easier, it being usually possible to remove it with the cold snare introduced through the nose or to twist it from its attachment with forceps or fingers from the mouth. It shows little or no tendency to recurrence.

Enchondroma.—Bosworth reports from literature only 2 cases of enchondroma of the naso-pharynx. Nasal obstruction, with headaches and some external deformity from pressure, were noted.

Hairy Pharyngeal Polypi.—Reports of ten of these curious growths have been collected by Conitzer,[2] who contributed to the number a case of his own. They contained not only hairs and their follicles, but also the other normal constituent parts of the skin. Most of them also contained cartilage. They were pedunculated tumors, attached usually to the posterior surface of the soft palate and more frequently to the left of the median line, but some in the vault and posterior wall of the pharynx. They were presumably all congenital. A similar growth was reported by Wagner,[1] in 1884, who called it a *dermoid cyst.* It is not included in Conitzer's table.

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[1] *N. Y. Med. Journ.*, Sept. 19, 1896.

[2] *Deut. med. Woch.*, No. 51, 1892.

Under the head of *Teratomata,* a number of similar cases are referred to by Lennox Browne, in Burnett's *System of Diseases of the Ear, Nose, and Throat,* vol. ii. p. 726; and he speaks of them as occurring also in the middle and lower pharynx.

Sarcoma of the Naso-pharynx.—Sarcoma is an occasional occurrence in the naso-pharynx. Bosworth,[2] in 1892, had collected from literature 18 cases, and added the complete history of a remarkable case of his own. Fourteen of these cases were in males and 5 in females. Their ages ran as follows:

1 to 10	2	30 to 40	2
10 to 20	5	40 to 50	7
20 to 30	3		

We see here, as in sarcoma of the nose, that from forty to fifty is the decade of life furnishing the largest number of cases.

It is hardly necessary to repeat here the history of the symptoms of naso-pharyngeal fibroma, which those of sarcoma so closely resemble; but it is more profitable to point out some differential points. In the first place, we do not expect fibroma after twenty-five years of age, but younger than this the growth in question may be either sarcoma or fibroma. The symptoms have usually run a more rapid course in sarcoma, and on examination it will be seen there has been a correspondingly rapid growth in the tumor. Epistaxis, while as frequent, is not apt to be as copious as in fibroma. Ulceration of the surface appears earlier. In Bosworth's case and in one other there was a general diffusion of the growth over the pharynx. Under the microscope the appearances are usually characteristic enough; but even here the diagnosis of sarcoma, especially when of the round-celled variety, is in some cases extremely difficult. Many cases of undoubted fibroma present in places histological appearances almost identical with round-celled sarcoma.

The **prognosis** is almost uniformly bad, although Bosworth's case recovered after piecemeal removal with the snare, and Warren's cases were all well or nearly so after external operation. This is so unusual as to raise some doubt as to the diagnosis, although well certified to in Bosworth's case.

Treatment.—Fortunately the treatment does not hinge on a differential diagnosis between fibroma and sarcoma. Prompt and thorough removal by intranasal procedure, if possible, is indicated in both cases. In Bosworth's case this was done piecemeal with the cold snare, and although the mucous membrane was extensively infiltrated, complete success was attained and the growth had not recurred after seven years. While encapsulated or circumscribed sarcomata may be thoroughly removed by means of the snare, it is difficult to conceive how a new growth, with malignant potentialities widely infiltrating the tissues, can be so thoroughly removed by means of a snare, which necessarily only removes surface-protuberances, as to destroy its power of growth; yet the microscopical diagnosis in the case is indisputable, so far as the skill of the examiners is concerned.

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[1] *Diseases of the Throat and Nose.*

[2] Since then cases have been reported by Thomas, Bennett, Delie, Lange, McIntyre, Cohen, Paige, Robertson, Iwanicki, Logan and Scheineman, and a case is reported by the U. S. Surgeon-General's Office, references to all of which will be found in the *Centralblatt für Laryngologie,* from 1887 to 1895 inclusive. In addition to these, cases have been reported by Zematski (*Sajous's Annual,* 1895, vol. iv., D 49), Delavan (*Journal of Laryngology,* 1894, p. 360), and Warren (3 cases, "Surgical Pathology"). I know of 2 other cases, which have not as yet been reported.

The treatment by external excision is so frequently fatal and ineffectual that the question of its advisability is in many cases doubtful.

Carcinoma.—Carcinoma of the naso-pharynx is of much rarer occurrence. Bosworth having had one case himself, has collected from literature the records[1] of 5 others. In only one of the latter, however, does there seem to have been a microscopical examination. I have a microscopical section of another case which was reported by the late Dr. Sidney Allan Fox[2] of Brooklyn. An abstract of the history of this case may be of value here.

The patient was a man forty years old. Family history was good and the patient had always enjoyed good health. A year previous to his coming under observation he was much exposed to wet and cold weather. This was followed by sharp pain in the ear, partial deafness, and a feeling as if his own voice was very loud. His general strength began to fail somewhat, and his nervous system to deteriorate. Six months later he began to be troubled very much with headache, especially in the daytime. He was also troubled with the earache above mentioned, with deafness and with obstruction of the posterior nares. When he came under observation his appetite was poor; he was unable to sleep at night because of an inability to breathe through the nose and the constant annoyance of mucus dropping in the throat. His hearing was defective and he was diploic. The odor from the naso-pharynx was fetid in character. Anterior rhinoscopy showed nothing, but posteriorly the naso-pharynx was seen to be filled by a cauliflower-like growth. The lateral walls of the pharynx, as well as its posterior wall, were matted with the growth, as were also the choanæ and the spaces about the Eustachian orifices. *There was no evidence of external or internal glandular involvement.* Microscopical examination showed it to be an epithelioma.

A preliminary operation (Annandale) was done by Dr. Fowler, and as much as possible of the growth removed. It rapidly grew again, and the patient died two months later. Autopsy showed that the growth had perforated the base of the skull, involved the brain, and had extended into the left orbit, possibly also the right.

As was said in speaking of the treatment of nasal sarcoma, the best hope that can be held out to the patient in advising such a surgical operation is that he may not survive it. Life can doubtless be prolonged more by cleansing and cautious removal of obstructing protrusions of the growth with the cold snare than by any radical operations.

BENIGN NEOPLASMS OF THE FAUCES, TONSILS, AND ORO-PHARYNX.

By the oro-pharynx we mean that portion of the anatomical pharynx which, we may say roughly, can be seen by direct vision in its whole extent—*i. e.*, from the level of the hard palate to the level of the arytenoid summits. Below this point the region belongs to the digestive, and not to the respiratory, system.

Papilloma of the soft palate, and especially of the uvula, is the most common of all true tumors of the nose and throat. They vary from the size of a pin's head to that of a cherry, though the majority of them are not larger than a pea. They are more frequently found on the anterior than on the posterior surface. They are attached frequently to the free edge of the soft palate and faucial pillars. They are of the same structure as true papilloma, or fibroma papillare, elsewhere. The normal epithelium lining the oropharynx, made up of pavement-cells, is exposed to attrition by the passage of food and the rubbing of opposing mucous surfaces. Probably it is to this, rather than to the change in the type of epithelium which takes place behind and above the soft palate, that we are to ascribe the frequency of these growths. Jurazs[1] speaks of having seen 14 cases in his clinics, of which 10 were between twenty and thirty, and all between nineteen and forty-four years of age. Eleven of them were men.

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[1] Fereri, *Archivi di Otologia*, 1893, p. 40, has reported a case, and McBride another, *Diseases of the Throat, Nose, and Ear*, p. 322.

[2] *N. Y. Medical Journ.*, March 8, 1890. The editor has specimens, from a case of Politzer, involving the Eustachian tube.

Symptoms.—They usually give rise to no symptoms, but are frequently seen in examining the pharynx, either as sessile warts on the mucous membrane or as pedunculated growths hanging from the tip of the uvula or the edge of the palate. Sometimes they cause tickling and coughing; but this seems to depend quite as much on the idiosyncrasy of the patient and the hyperesthesia of the mucous membrane as upon the size and shape of the growth.

The **diagnosis** is easily made from the gross appearances, and because it is by far the most common of all growths in this locality; but occasionally the best of observers is deceived. A notable instance of this was in a case reported by Dr. Lefferts,[2] in 1889, as a typical papilloma in a girl of sixteen. He made no microscopical examination.[3] The growth recurred after removal, and was again removed by Dr. Simpson[4] and reported by him, after microscopical examination, as an instance in which a benign neoplasm had degenerated into a sarcoma. It seems very evident that the growth was malignant from the first. Lennox Browne relates[5] a similar mistake as occurring in the practice of Morell Mackenzie; so that, however great the probability, the microscope must complete the evidence.

Prognosis.—They are benign growths and, as a rule, of no significance.

Treatment.—When large enough to cause symptoms or give the patient any alarm, they may be cut off with a pair of uvula-scissors.

Fibroma.—Bosworth refers to 7 cases in the tonsils and 7 in the oropharynx. Lefferts[6] has reported a case. They are benign growths and easily removed.

Angioma.—Phillips has reported a case,[7] Bosworth refers to 2 others, and Flatau to another.[8]

Lipomata have been reported by Farlow[9] and Schmidt.

Adenoma.—Natier reports a case.[10] He refers to 2 cases by Hutchinson.[11]

Cysts of the Mucous Membrane.—I have observed one case in a middle-aged woman who complained that something had been growing in her throat for the last eighteen months. A small round tumor, a little larger than a pea, was seen growing at the base of the right posterior faucial pillar. It was smooth and sessile. It gave no evidence of its presence until the patient, who had a family history of cancer, noticed it. Fig. 632 shows a section of the walls, which are fibrous and lined on both sides with squamous epithelium similar to that of the surrounding mucous membrane. There were no glands and no lymphoid tissue. Its fluid contents escaped in the removal. It was probably an inclusion-cyst, having its origin in some acute inflammatory condition of the mucosa.

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[1] *Die Krankheiten der Oberen Luftwege*, 1891.

[2] *Trans. Amer. Laryng. Assn.*, 1889.

[3] This case is quoted by Bosworth, and accepted as a papilloma, in his book published just after Dr. Lefferts's report and before Dr. Simpson's.

[4] *Trans. Amer. Laryng. Assn.*, 1893.

[5] Burnett's *System of the Diseases of the Ear, Nose, and Throat*, vol. ii. p. 724.

[6] *Loc. cit.*

[7] *N. Y. Medical Record*, March 12, 1887, p. 293.

[8] *Nasen, Rachen und Kehlkopf Krankheiten*, p. 331.

[9] *Trans. Amer. Laryng. Assn.*, 1895.

[10] *Rev. Mensuelle de Laryngologie*, No. 11, 1887, p. 618.

[11] *Lancet*, May 22, 1886, p. 973.

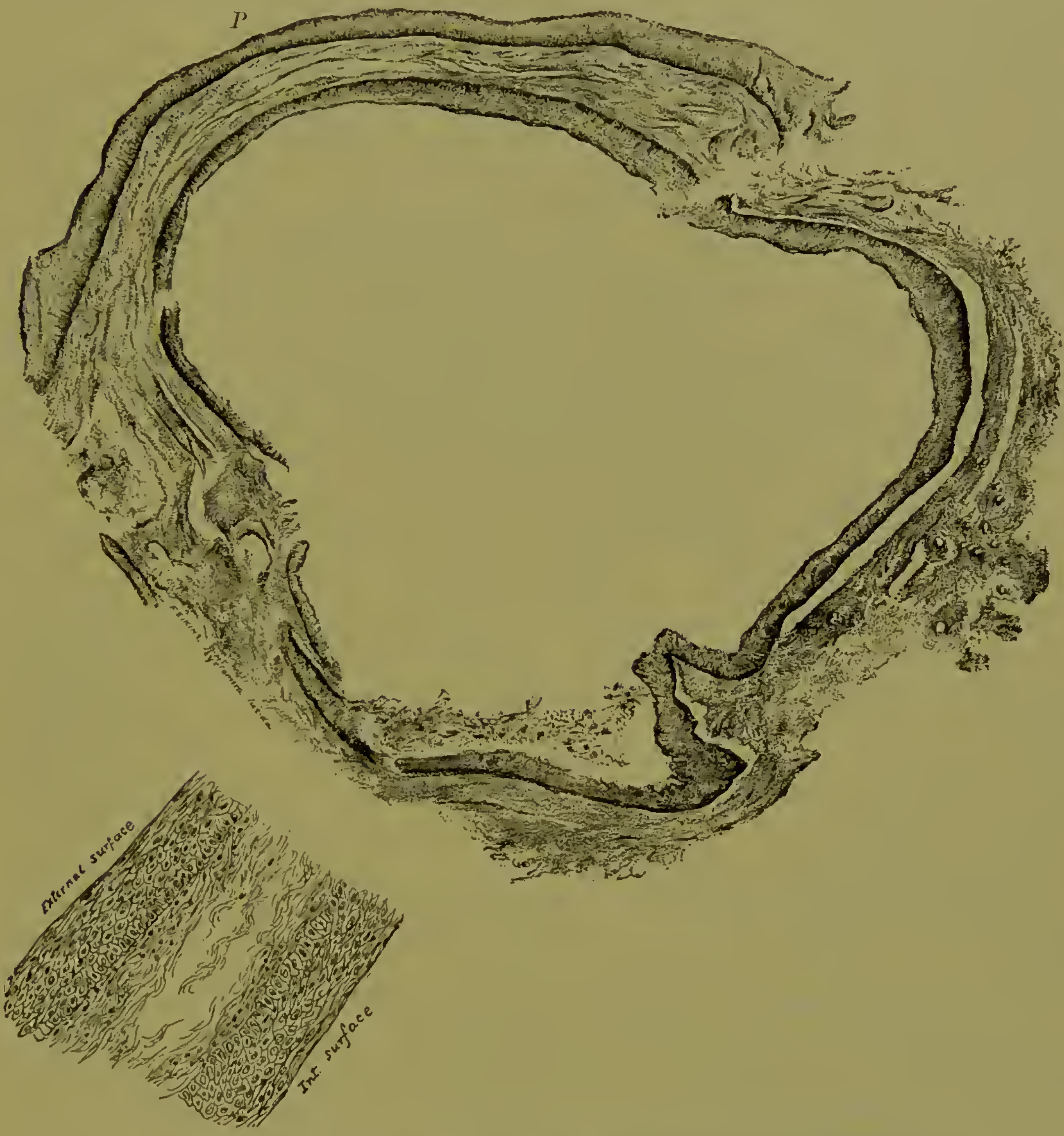

FIG. 632.—Oro-pharyngeal cyst: *P*, point from which high-power drawing is taken.

It will be noted in Schmidt's table that he mentions one cyst of the oro-pharynx, but gives no further details.

There is a growth connected with the tonsils which is occasionally seen in the throat—usually but wrongly called a *supernumerary tonsil*. Its formation seems to be brought about by a fibrous growth shutting off a portion of the lymphoid tissue of a hypertrophied tonsil. The fibrous tissue is gradually lengthened into a pedicle. Such a growth I have examined microscopically for Dr. W. F. Dudley of Brooklyn. These growths, as well, indeed, as many others of the oro-pharynx, may by the length of their pedicle cause alarming dyspnea or interfere markedly with deglutition.

MALIGNANT TUMORS OF THE FAUCES.

There seems to be a certain practical line of division between malignant disease of the contiguous structures of the soft palate, tonsils, and oro-pharynx, due, doubtless, to difference in anatomical structure, physiological function and pathogenic influences. This makes it seem desirable to consider them separately.

On looking over Schmidt's tables we see that more *carcinomata* were observed in the oro-pharynx and larynx than all other growths combined, if we rule out papillomata and the inflammatory growths, the so-called laryngeal fibromata and tubercular tumors. It will also be seen that it is very much more frequent in men than in women—at a ratio of 15 to 1 for the pharynx. This same influence of sex is discernible in the reports of 30 cases of carcinoma of the fauces collected by Bosworth. Only one was in a woman. Bosworth comments on this as a curious coincidence. The chances are very great, however, that there is hidden behind the fact an etiological significance of which we can at present form no surmise. The cases that I have observed and know of personally have all been in men. We can hardly suppose that the greater exposure of men in their occupation to irritative causes would entirely account for this.

Sarcoma of the Soft Palate.—A few cases have been reported, Bosworth, in 1892, collecting 20. It is much more frequent in males (13 to 4), and occurs as often in patients over forty years of age as in younger ones.

All forms have been noted, with no especial preponderance of any one.

Symptoms.—It is usually of slow growth and does not tend to ulcerate quickly. It frequently gives rise to no symptoms until it has existed some time. Interference with deglutition and the thick sound of the voice may be the first symptoms complained of. Pain, however, may be prominent from the first, and this is especially so if ulceration has occurred, in which case excessive salivation and foulness of the breath add to the discomfort of the patient. The general health deteriorates. As a rule, glandular involvement in the neck does not occur until the growth has invaded other structures. Hemorrhage is not reported as an incident in the course of the disease.

The tumor is usually circumscribed—a round, smooth growth covered by mucous membrane and enclosed in a capsule, or it may be more diffuse and nodulated. It may spring from any part of the soft palate and spread over its whole extent, but does not show a marked tendency at first to invade contiguous structures.

The **duration** of the disease varies from six months to several years. Sometimes it has apparently existed for years in a quiescent condition.

Diagnosis.—The same caution should be observed in excluding a syphilitic growth by the administration of large doses of the iodid of potash. This should be especially borne in mind when the microscope reveals round-celled structure.

It is easily distinguished from tuberculosis, which almost never occurs without manifestations elsewhere. From fibroma it cannot be surely distinguished without a histological examination. The rarity of fibroma in this situation, and the slowness of its growth, its firmness of consistence, and the lack of pain in the history will tend to exclude it.

The **prognosis** is always grave; but not a few cases have been reported in which many years had elapsed without any recurrence after thorough operation. Much will depend on the rapidity of growth and involvement of neighboring structures. Those cases are particularly favorable which are seen early.

Treatment.—Incision of the mucous membrane may enable the operator to shell out an encapsulated growth; but usually the field of operation should include healthy tissue, and suspicious areas should be thoroughly burned out with the thermo-cautery. No radical operation should be undertaken unless with hope of the complete extirpation of the growth. Without such hope, removals of projecting and obstructing portions with the snare (from time to time) may be advisable. The use of a cleansing mouth-wash, such as the ordinary Dobell solution or the peroxid of hydrogen, will tend to relieve the fetor. Weak solutions of cocain or a 10 per cent. spray of antipyrin help to assuage the pain when violent. The liberal use of opiates is indicated in these hopeless cases.

Carcinoma of the soft palate, although somewhat more frequent than sarcoma, is still a very rare growth. Bosworth has collected the reports of 30 cases up to 1889. In looking over Semon's *Centralblatt für Laryngologie* for the years since then, I can find a reference to only one case.[1] We see at once what a marked contrast this forms to the frequency of epithelioma of the tongue; while the benign epithelial growth—papilloma—is so frequently seen on the soft palate and so rarely on the tongue.

Among Bosworth's cases is one of twenty-five and another of twenty-seven years of age; but forty to fifty shows a slightly larger number (5) than any other decade.

Of the 31 cases, including Katzenstein's, all but one were in men, affording a more striking example even than sarcoma of the greater frequency of malignant growths of the throat in men. Owing to insufficient microscopical reports, it is impossible to ascertain what form of carcinoma is most frequent.

It occurs as a rapidly growing infiltrating neoplasm with a fungous or irregular surface. Ulceration occurs early in its course.

Symptoms.—Pain radiating in various directions is usually the prominent symptom, but is not always present at first. Stiffness of the palate is complained of in some cases. Notwithstanding these symptoms, the growth has usually advanced so rapidly that, when it comes under observation, considerable infiltration of the soft palate and ulceration have already taken place. The ulceration is characteristic as of cancer elsewhere. The underlying infiltration raises the floor of the ulcer, while the surrounding fibroid border is not sharp-cut, but rounded. The floor of the ulceration may be covered with whitish secretion or may be fairly clean and pink-looking; but it is always irregular and nodular. Hemorrhage frequently occurs and the general health rapidly deteriorates. Foul-smelling secretions from the ulcer and lancinating pains destroy the appetite and render the patient's life miserable. Glandular enlargement is sometimes absent even in late stages of the disease, and is usually not present until the disease has spread to contiguous structures. This, however, it rapidly does, involving the base of the tongue, the lateral pharyngeal wall, and the hard palate; but, as Bosworth remarks, they usually die even before this takes place.

The **prognosis** is entirely hopeless.

The **diagnosis** from sarcoma has been sufficiently indicated by the previous remarks. The microscope must, of course, be the final arbiter between the two. As between cancer and syphilis, the microscope is a perfectly satisfactory means of diagnosis and should always be promptly employed. Carcinoma rarely resembles papilloma in this situation. The infiltration is marked.

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[1] Katzenstein, *Berl. klin. Woch.*, No. 9, 1892.

Treatment.—Occasionally a radical operation may be advisable; but usually this holds out to the patient no hope even of diminishing suffering. Cleansing and disinfecting washes and opium include the palliative indications.

Sarcoma of the Tonsils.—Gray,[1] in reporting a case, gives a list of 18 other reports of sarcoma found in literature. I have been able to find trustworthy accounts of 13 other cases[2] since then. Others have been reported; but either the reports are not accessible to me or satisfactory data are not given. Indeed, Bosworth in his book has collected 45 cases, and others have been reported since then. Of the 32 cases which I have studied, the following facts are apparent. As lympho-sarcoma and round-celled sarcoma are synonyms in the reports, we find that all the cases but 5 come under that one head, showing pretty conclusively that the growths, as a rule, spring from the lymphoid, and not from the fibrous, elements of the tonsil, even at an age when the lymphoid activity has sunk into insignificance.

From	50 to 60	there were	9	cases.
"	60 to 70	"	8	"
Over	70	"	4	"
From	10 to 20	"	3	"
"	30 to 40	"	2	"
"	20 to 30	was	1	case.
"	40 to 50	"	1	"
Younger than	10	"	1	"

From this analysis we see that more than half the cases occurred in persons over fifty years of age. With the exception of one case of six years, the 3 youngest cases were seventeen years old. Therefore we see that this lymphoid growth almost always occurs in the pharynx at an age when benign lymphoid hypertrophies (enlarged tonsils) are unknown to begin. Sex seems to have no influence (13 to 17); and there seems to be no marked preponderance on either side of the throat.

Symptoms.—The onset of the symptoms frequently resembles an attack of tonsillitis. Instead of entirely subsiding, some swelling and tenderness are left behind. This may remain stationary for a few weeks; but gradually the size of the tonsil increases, the surrounding tissue of the pillars of the fauces and the soft palate and uvula become reddened and edematous. The pain increases, as a rule, although in some cases it is never a prominent symptom. Ulceration occurs much earlier than is usual in sarcoma. Glandular involvement is also more frequent and comes on earlier. Hemorrhage is an occasional symptom. The general health becomes seriously affected after a few months; the sense of taste and smell are soon lost; foul discharge and odor are present. The growth may extend backward and downward, interfering with deglutition and respiration.

Prognosis.—The disease usually goes to a fatal termination within a year, and sometimes in a few months. Round-celled sarcoma in any situation has a most unfavorable prognosis, but in the tonsil it is especially rapid and fatal. One of Newman's cases lived five years after the operation and died of a recurrence in the other tonsil: this was a spindle-celled sarcoma. Weinlechner's case (quoted by Bosworth), another spindle-celled sarcoma, was injected with iodoform and ether and the common carotid artery was tied after the case had been pronounced hopeless by Billroth: the case entirely recovered. Another case, which was called a lympho-adenoma, lived two and a half years after operation, and still another lived seven years. In reading the literature it seems that the chance of a favorable prognosis is proportionate to the chance of mistake in diagnosis; and the suspicion arises that the microscope or our understanding of the pathology of sarcoma is at fault.

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[1] *Amer. Journ. of Medical Science*, February, 1889, p. 154.

[2] MacCoy, *Phila. Med. News*, Feb. 2, 1889; Mygind, *Journ. of Laryng.*, Aug. 1890, p. 301; Cheever, *N. Y. Med. Record*, May 25, 1889; Wolfenden, *Journ. of Laryng.*, Oct., 1889; Schönborn, *Centralblatt für Laryng.*, vol. v.; Lediard, *Journ. of Laryng.*, 1890, p. 17; Homans, *Journ. of Laryng.*, 1891, p. 428; Cohen, *Phila. Med. News*, Jan. 27, 1894; Wagner, *N. Y. Med. Record*, Feb. 3, 1894; Watson, *N. Y. Med. Journ.*, Nov. 10, 1894, p. 584; Newman, *Malignant Growths of the Throat and Nose* (2); Mikulicz, *Atlas der Krankheiten der Mund und Rachenhöhle.*

Diagnosis.—What has been said of tertiary syphilis, in connection with the diagnosis of sarcoma elsewhere, applies with equal force to tonsillar growths. The growths are so rare that differential diagnosis between sarcoma and carcinoma can only be settled by the microscope, because no one's experience is wide enough to trust to the "clinical sense" which is of value in so many cases. Iodid of potash and the microscope should be our chief aids.

Treatment.—Owing to the hope, though a forlorn one, which has been realized in a few cases, thorough extirpation should be undertaken where it is a possibility. The necessity of an external incision for the removal of diseased glands, as well as for the complete removal of the growth, is frequently evident. Otherwise, palliative measures are to be adopted as mentioned above.

Carcinoma of the tonsils is of more frequent occurrence than sarcoma. About 100 cases may be found in literature.[1]

It has been reported in a case as young as seventeen (Bryant) and as old as eighty-two. Sarcoma, however, has not only been reported at a younger age (six), but also in a woman of eighty-nine. The average age of carcinoma, according to Bosworth, is fifty-two and one-half years. It occurs much more frequently in males.

Calculating from the figures given by Bosworth, it occurs in the tonsils about once in 2000 cases of carcinoma of all parts.

Symptoms.—A careful study fails to note any essential difference between the subjective symptoms of sarcoma and those of carcinoma of the tonsils. The **duration** also seems to be about the same—from a few months to a year and a half.

Diagnosis.—The appearance of the growth seems to vary a little from that of sarcoma. There is more apt to be ulceration with carcinoma. A fleshy pinkish mass, fungoid and rough, projects into the pharynx, sprouting from the swollen tonsils and the infiltrated mucous membrane around it. A sarcoma, on the other hand, usually shows a smooth projecting surface, and is less completely covered with ulceration or fungoid excrescences. However, as said before, the microscope must be the final arbiter, for nothing is so deceiving as the external configuration of tumors.

The **prognosis** is, of course, as bad as possible, although in one of Newman's cases operated upon by him, there was no recurrence at the end of two years, and in another case no recurrence at the end of five months.

Treatment.—It is hardly necessary to speak of treatment. The only treatment for cancer is the knife and at once, if there is any possibility of complete eradication of all the tissue. Palliative treatment has been mentioned above for sarcoma.

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[1] Bosworth refers to about 85 cases. Newman has reported 8 other cases since Bosworth, and several others are referred to in literature since the publication of Newman's work.

Sarcoma of the Oro-pharynx.—Few authenticated cases have been reported. Dr. F. I. Knight[1] reported a case in 1879, and reviewed the reports which had been made, of pharyngeal growths, up to that time; but many of them were apparently not really sarcoma. Bosworth, in 1892, mentioned 14 or 15 cases. By referring to Semon's *Centralblatt für Laryngologie*, I find the following cases reported since 1886:

Felix: *Monatsch. f. Ohren.*, 1894, p. 255.
2 cases, spindle-celled; pedunculated; removal successful.
Montaz: *Médécine Mod.*, Sept., 1894.
"Lymphadenoma;" eleven years old; death from suffocation.
Delmas and Cannieu: *Journ. de Méd. de Bordeaux*, No. 14, April 7, 1895.
Hoppe: *Die Maligne Geschwülste der Pharynx. Dissert.*, Berlin, 1892.
Katzenstein: *Berl. Laryng. Soc.*, May 20, 1892; in *Centralblatt für Laryngologie*, No. 9, 1892. Short notice, 2 cases in report.
Cheatham: *Amer. Practitioner and News*, Dec. 7, 1889.
Norton: *Med. Press and Circular*, May 22, 1889.
Felici: *Il Morgagni*, March, 1888 (mentioned by Bosworth).
Black: *Glasgow Med. Journ.*, Feb., 1886.

This makes a record of 25 or 30 cases altogether, and the list is tolerably complete.

We have seen how malignant a growth is sarcoma of the tonsils. When it occurs in the oro-pharynx this is far from being the case. In this locality the growth is very frequently pedunculated or has a small base of attachment. It grows more or less slowly and does not have a tendency to glandular involvement. It is more frequently of the spindle-celled variety, which is usually less virulent. They are reported as springing from the posterior pharyngeal wall or low down on the sides of the pharynx.

Their usual occurrence is after middle life, although we again see here an instance in a child of eleven years. It is here also more frequent in men.

Symptoms.—It usually gives rise to no symptoms until deglutition or respiration is interfered with, which occurs at an early date, however, owing to its situation and the common presence of a pedicle. It may cause cough by encroaching in its growth upon the arytenoid summits or folds. Dyspnea from this cause has been reported as severe and dangerous; and, in the case of the child reported by Montaz, death occurred from the impaction of a portion of the growth in the larynx. As to duration, it seems from the histories that the disease may extend over several years, although it is sometimes rapidly fatal.

Prognosis.—Of course, the usual termination is in death; but if the tumor is such in shape and situation as to allow of complete removal, there is a fair chance of no recurrence; and if it recurs, a second operation may be more successful.

Treatment.—When pedunculated and not too large, the growth may be removed with the galvano-cautery snare. When, however, it has a broad base of attachment, or when it is so large as to make such a manipulation of doubtful success, a lateral, or better a subhyoid, pharyngotomy may be done. One or two cases were operated on through the mouth after preliminary tracheotomy.

Carcinoma of the Oro-pharynx.—Below the tips of the arytenoid cartilages—*i. e.*, in the laryngo-pharynx—carcinoma, often of scirrhous nature, is a very frequent occurrence. Above this point, however, it is one of the rarest of growths (Fig. 633).

Bosworth refers to about 30 cases, although some of these had their origin

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[1] *Trans. Amer. Laryng. Assn.*, 1879.

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evidently in the laryngeal part of the pharynx. I have been able to find very few reports since then.

The variety is usually epitheliomatous or scirrhous. One case was reported as young as twenty; but pharyngeal carcinoma is no exception to the rule which obtains elsewhere as to age. The larger number of cases seem to have been in females, a contrast to what we have hitherto noted in neoplasms of the upper air-passages.

Symptoms.—Gradually increasing discomfort and pain in swallowing first attract the patient's attention. Extension of the growth to the larynx and esophagus causes dyspnea and increases the difficulty of deglutition. Involvement of the cervical glands occurs early, and deterioration of the general health rapidly ensues. There may or may not be any bleeding. The duration of the disease is from six to eighteen months.

Prognosis is of course bad, but some prolongation of life by early surgical interference may be expected in favorable cases.

Treatment, if radical, of course belongs to the general surgeon. Tracheotomy, feeding *per rectum*, and opium are the palliative measures that are indicated in some of the cases.

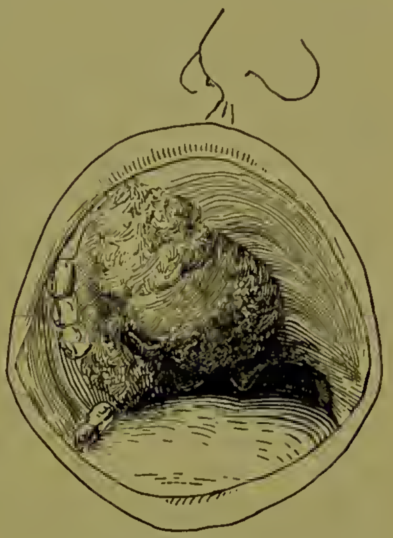

FIG. 633.—The author's case of epithelioma of the oro-pharynx in a man of sixty, springing from base of post-faucial pillar. Began about five months before drawing was made.

BENIGN NEOPLASMS OF THE LARYNX.

It is said by Moure,[1] quoting from Schwartz's tables of Fauvel's cases, that these growths occur in about 1 per cent. of the cases of laryngeal disease. Of late years chronic laryngeal disease, except the specific lesions of tuberculosis, syphilis, and cancer, seems almost to have disappeared from our nose- and throat-clinics in America. There is hardly any way of explaining this except by suggesting that the prompt and thorough treatment of nasal diseases, which all patients receive in this country, has produced this marked diminution of laryngeal disease.

It is my impression, however, that the proportion of benign growths to other affections of the larynx is rather more than 1 per cent. in New York City. Nevertheless, such are exceedingly rare, and very few of us see more than a very few cases each year in the public clinics. One has only to look at the works of Türck, Störk, Fauvel, and Mackenzie to realize that the early laryngologists saw a much larger number than occurs in the practice of any laryngologist to-day.

This may be graphically seen on referring to Semon's statistical tables[2] of his investigations, where Fauvel and Störk each say they had seen 600 cases of benign laryngeal growths, and others with "prerhinological" experience note very large numbers.

They are more common in men than in women. According to Mackenzie, out of 287 cases of benign laryngeal growths in his own practice and in that of others, 197 were males and 90 were females. They are most common in middle life, although some forms—as papilloma—are more frequent in children. They are more common in those who make professional use of their voices. In children an attack of the measles has been frequently noted as the time at which the symptoms of papilloma began. Syphilis and tuberculosis produce their own neoplastic phenomena in the larynx, but have no appreciable influence in producing independent tumors.

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[1] *Leçons sur les Maladies du Larynx*, p. 394.

[2] *Centralblatt für Laryngologie*, March, 1889.

Looking at Schmidt's tables, we again note the great preponderance of certain laryngeal growths. Fibroma, papilloma, singers' nodes, and tubercular tumors so far outnumber the other benign growths—lipoma, myxoma, and cysts—that the contrast is striking; while adenoma, chondroma, angioma, neuroma, with others which Gerhardt mentions,[1] have not been seen in his experience. This clinical fact alone, which is the common experience of all laryngologists, is strongly suggestive of the conclusion that, if they are not all of them results of chronic inflammation, the latter is a prominent factor in their etiology.

"Singers' nodes" are acknowledged by all to be the direct products of chronic inflammation. The name refers to their external appearance and the etiological factor in their occurrence. Their histological structure, while always giving evidence of inflammation, is not always the same. Occasionally the principal hyperplasia is in the epithelium, whose flat layers are thickened and supported by subjacent structure. More frequently there is marked increase in the lymphoid elements, raising up the epithelium into surface-protuberances; while in other cases the stroma is increased in volume, and frequently its fibers are separated by effused serum. Usually, however, there is a combination of these pathological changes with an increase of the vascularity of the parts. They are seen only upon the true cords, nearly always in their anterior thirds, either upon their superior surfaces or at their edges. They are sometimes bilateral at the edges, but of unequal size, having the appearance that one had been formed first and then affected by attrition the edge of the opposite cord. Occasionally it will be observed that the protuberance on one cord has made a little concavity at the edge of the opposite cord (see page 1105).

Etiology.—They occur chiefly among professional people who overuse their voices. This especially is the case in amateur singers. It is occasionally observed in news-boys and in choir-boys.[2]

Symptoms.—A young woman who has been singing a few months, or a vocalist from the music-halls who has been overstraining her voice, comes with the complaint of inability to produce certain notes or that a very little practice tires her larynx. Later in the course of the trouble there is complaint of occasional hoarseness and fatigue of the voice in ordinary conversation. The patient may be otherwise in perfect health.

Examination reveals one or both cords congested and rough at the edge or throughout the whole extent. It may be swollen and ecchymosed, and looks as if it had been bruised between two hard surfaces. A sessile growth from the size of a pin's head to that of a split pea may be seen on the anterior part of one or both cords, or there may be a number of these little protuberances scattered over their surfaces.

Prognosis, of course, relates entirely to the restoration of the voice, and this depends largely on whether the voice has broken down under use or abuse. It is doubtless true that in many of these cases the trouble at the bottom is really a natural structural weakness of the vocal organs. In others overuse of the voice has produced the trouble. The former cannot be corrected, and these patients cannot sing except in extreme moderation; but the ordinary voice may be entirely restored. Others, by proper care and treatment, may regain the singing-voice.

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[1] "Kehlkopfgeschwülste," Nothnagel's *Specielle Path. und Therapie.*

[2] Moure, "Laryngite Nodulaire des Enfants," *Revue Hebd. de Laryngologie,* Nos. 6, 7, 8, 1896.

Treatment.—First, rest as absolute as possible must be insisted on for the larynx. The patient should not be allowed to talk more than necessity requires. The air-passages in the pharynx and nose must of course be put in order. Applications of nitrate of silver or sulphate of zinc (10 gr.–℥j) should be made daily or three times a week. Usually after several weeks this will result in the subsidence of the neoplasm. If it is of large size and should persist, attempts at removal may be made. It is occasionally of such a size and shape that it may be seized with forceps or shaved off with the laryngeal guillotine or snare. The laryngeal bistoury, either protected or unprotected, cannot be too strongly condemned. The most disastrous wounds have been inflicted by it even in skilled hands.[1] The galvano-cautery electrode is usually to be preferred for operative procedures on these growths.

Laryngeal Polypi.—By this term we understand benign growths of the larynx, whatever their histological structure, which have more or less circumscribed bases of attachment. Their symptomatology and treatment are so nearly identical that these will be spoken of as a whole, following a brief account of the pathogenesis, histology, gross appearances, and occurrence of each.

Edematous Polypi of the Larynx—the so-called Fibromata.—As in the nose, where edematous hypertrophies of the mucous membrane are often called myxomata, so in the larynx we find practically the same structure in growths, which until very recently have been almost universally called fibromata or fibro-myxomata.

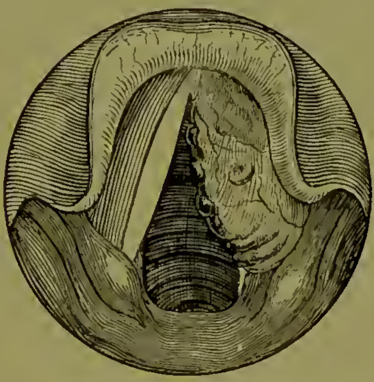

FIG. 634.—Angioma of larynx (from Krieg's Atlas).

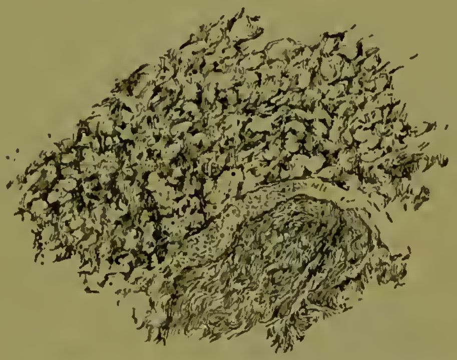

FIG. 635.—Edematous fibroma of vocal cord.

In the nose these serum-soaked neoplasms are covered by a translucent columnar epithelium, and are scantily supplied with blood-vessels. In the larynx, on the other hand, they are covered by an opaque stratified pavement-epithelium. They are more exposed to bruising by the muscular movements of the vocal cords and the forcible air-currents in coughing and loud speaking, which produce extravasations of blood into the meshes of the separated stroma-fibers. These two circumstances give them either a solid white look or a dark-red appearance.

My own histological examinations as well as clinical experience lead me to believe that Chiari[2] is correct in stating that they are local hypertrophies of the vocal cords. Their structure closely resembles that of edematous nasal polypi. As has been stated, the surface-epithelium and the extravasated blood constitute the chief differences. There are also more blood-vessels, which are usually much dilated, making vascular channels across the loose stroma. Hyaline bodies are also frequently met with, and supposed to be due to the degeneration of the stroma-fibers (Fig. 635).

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[1] See Schrötter's *Vorlesungen über die Krankheiten der Kehlkopfes*, 1892, p. 295.

[2] *Archiv für Laryngologie*, Bd. ii., Heft i.

Etiology.—In studying their structure we see at once that they are the result of chronic inflammation, and therefore have the same cause as do the singers' nodes already referred to. As a matter of fact, their structure is identical with many of the latter growths, which may therefore be looked upon as early stages of laryngeal polypus. They are more common in men, and are seldom seen in children.

Physical Appearances.—They are smooth, rounded bodies, which may be sessile or may have a long pedicle. They may be red and congested or look pale and opaque. They usually have their attachment to the anterior part of the true cords, but may also spring from the ventricles or false cords, the subglottic space (see Fig. 563), or from the anterior commissure. They may be very small, in which case they are usually sessile (singers' nodes); or they may be so large as almost to fill the larynx, leaving surprisingly little room for respiration. When large they are commonly pedunculated, pear-shaped growths. They are usually single, but may have several lobules.

Papilloma is of such frequent occurrence in the larynx and is so closely allied to various manifestations of inflammation, such as pachydermia and the surface-phenomena of certain tubercular and syphilitic lesions, that we must presume that the local irritation of inflammation is an important element in its pathogenesis. Generically it has been classified by pathologists among the fibromata and called a papillary fibroma; but its chief characteristic is epithelial proliferation, and to be consistent with pathological laws it would seem that its name should rather be "benign epithelioma." According to Schmidt's tables, he met it in about 10 per cent. of his cases of laryngeal neoplasms. Schrötter[1] places its proportions at 18 per cent., while Moure[2] agrees with Bruns, Fauvel, Massei, Krishaber, and Elsberg in saying that it occurs in about 50 per cent., and Mackenzie puts the figure as high as 67 per cent. Schnitzler[3] says it is the most frequent of all laryngeal growths, especially in children; while in adults papilloma becomes less frequent and fibroma more common. This discrepancy probably depends on how many of the inflammatory nodules, already spoken of, are placed in the category of tumors. Its most frequent site of attachment is the vocal cords in their anterior third and at the anterior commissure, but it may occur everywhere in the larynx. A growth may have a long pedicle which allows its attachment beneath the cords, and yet the mass may present above them.

In *children* it presents certain features in diagnosis and treatment not observed at other periods of life nor in other growths. Congenital cases have been reported in which the child was aphonic from birth. In very young children laryngoscopical examination is usually unsatisfactory and always more or less incomplete. When the growths are situated in the upper part of the larynx they can sometimes be felt by the examining-finger. Hoarseness in a child, slowly increasing to aphonia and dyspnea, render the diagnosis exceedingly probable. Tracheotomy may then be indicated, in the course of which the diagnosis will be established. The growths are usually sessile and frequently disseminated. While Hooper[4] has succeeded in operating on children after tracheotomy, and even without it, by endo-laryngeal methods under ether, this is usually not practicable nor satisfactory. Tracheotomy should be performed, when indicated, for the dyspnea, and the tube left in for several months before thyrotomy is done, which may result in permanent loss of voice or serious impairment of it.

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[1] *Vorlesungen über die Krankheiten des Kehlkopfes.*

[2] *Leçons sur les Maladies du Larynx.*

[3] *Klinischer Atlas der Laryngologie.*

[4] *International Clinics*, October, 1891.

A large number of cases have been reported of spontaneous cure after tracheotomy, presumably due to the rest afforded the larynx. Thyrotomy may be done and the larynx thoroughly curetted and cauterized, but recurrence even then is common. Intubation has been tried in hope that the pressure of the tube would cause absorption of the growths, but not with satisfactory results.

Physical Appearances.—They may be single or multiple, with a long pedicle or broad-based. They may dot the surfaces of the cords as little buds or fill the whole cavity of the larynx with a fungus-looking mass, which may be pale or of a dark-red color. Their size, however, is not usually larger than a pea.

Differential Diagnosis.—There are certain conditions in the larynx which may give rise to a mistaken diagnosis of papilloma. The one which possesses most interest is *epithelioma.* As has been said, papilloma is itself a distinctly epithelial growth. Every laryngologist knows that occasionally a beginning cancer will present exactly the same appearance in the larynx as a papilloma. Indeed, there may be no carcinomatous elements in the surface-proliferations, and thus a microscopical examination of portions removed by endo-laryngeal procedure may be misleading. A papillary tumor occurring in the larynx under twenty-five is in all probability a benign growth. Occurring in a patient over fifty, who has had no previous laryngeal trouble, however benign in its appearance, it is always to be looked upon with suspicion. If it is pedunculated, and after existing several months the surrounding mucous membrane presents no appearance of infiltration nor zone of inflammation, it is presumably benign. Any limitation of movement in the excursion of the vocal cords is a suspicious circumstance, which if marked is almost pathognomonic of malignant disease. Recurrence after thorough removal in case of malignancy is apt to be accompanied by infiltration, while when benign this is not noted; but recurrence itself in a patient past middle life is not a favorable omen, although in children it is the rule in benign growths. Unless the piece removed for examination includes some of the tissue from which the growth springs, a negative microscopical examination is not conclusive. On the other hand, even a surface-clipping may show the character of the growth; but frequently a concentric arrangement of epithelial cells leaves the examiner in doubt as to their significance. Under such circumstances time must be

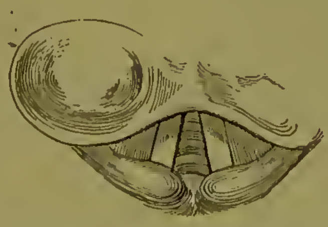
FIG. 636.—Cyst of larynx (from Mackenzie).

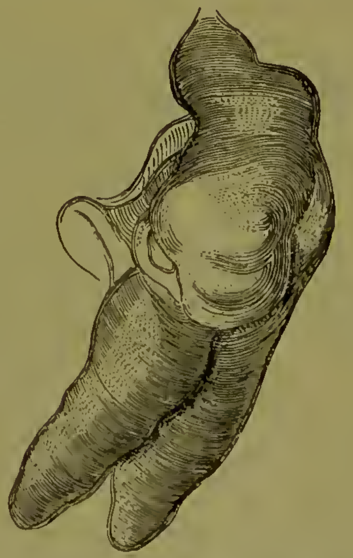
FIG. 637.—Lipoma of larynx (from Schrötter).

allowed to watch the progress of the case, but it should be examined at frequent intervals by a competent diagnostician.

Tuberculosis of the larynx presents occasionally an appearance which to the novice closely resembles a papillomatous growth (see Figs. 612, 616, 617, 622). Papillary masses at the posterior commissure, or, less frequently, more anteriorly, may so project into the larynx as to hide underlying infiltration or ulceration. Examination of the chest or sputum may even be negative or the former doubtful. The position of the growth at the posterior commissure, its sessile character, the paleness of the larynx, the prominence of cough as a symptom, and the general history of the case, will usually allow the experienced laryngologist to make a diagnosis without the aid of pulmonary signs. Microscopical examination will frequently show tubercle-bacilli; but these may also be absent, and only the epithelial proliferation is to be noted.

Cysts[1] (Fig. 636), angioma[2] (Fig. 634), myxoma,[3] lipoma[4] (Fig. 637), chondroma,[5] adenoma,[6] lymphoma[7] (Fig. 638), and colloid growths are all occasionally met with in the larynx, while amyloid degeneration[8] has been noted in various tumors.

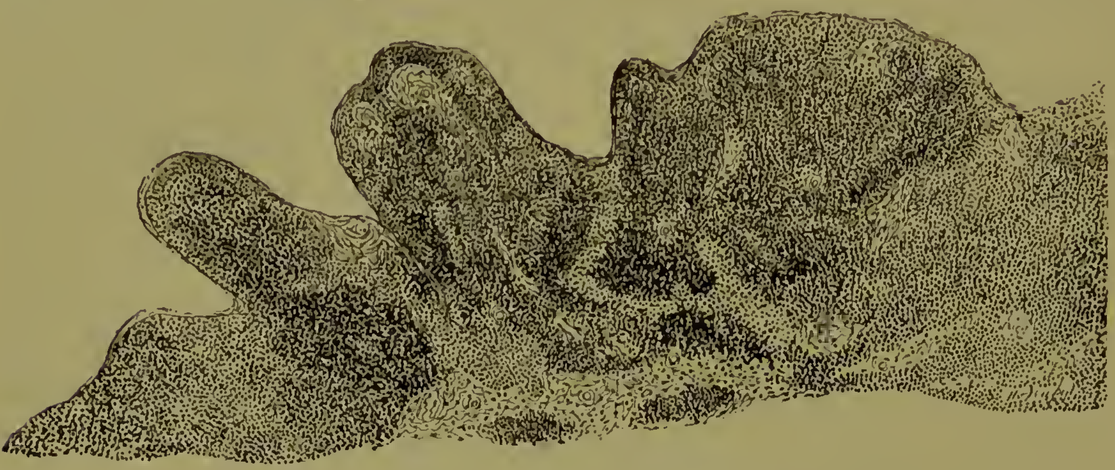

FIG. 638.—Papillary lymphoma of larynx.

Symptoms of Benign Laryngeal Growths.—In a general way it may be said that supraglottic tumors first produce cough, neoplasms of the vocal cords first give rise to hoarseness, and infraglottic growths to dyspnea; but it will be readily understood that no absolute rule can be laid down.

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[1] Garel, *Centralbl. f. Laryng.*, iv., 147; *Lyon. Méd.*, April 12, 1885; Richard Ubrich, *Dissertation*, Wurzburg, 1887; Ledderhose, *Deutsch. Zeit. f. Chirurg.*, xxix., 4, 1889; Ref. *Centralbl. f. Laryng.*, vi., 255; Chiari, *Centralbl. f. Laryng.*, viii., 308; Thost, *Deutsch. med. Woch.*, 1891, No. 20, p. 686; Ingals, *N. Y. Med. Journ.*, Sept. 1, 1894, p. 260.

[2] Wolfenden, *Journ. of Laryng.*, 1888, p. 291; Glasgow, *Trans. Amer. Laryng. Assn.*, 1888, p. 146; Loomis, *N. Y. Med. Record*, April 5, 1896.

[3] I have sections of two specimens in my possession. The reports of myxoma are so confused with those of edematous growths that it is difficult to distinguish the true from the false. Bosworth refers to 12 or 15 cases.

[4] Farlow, *N. Y. Med. Journ.*, ii., p. 610, Nov. 16, 1895; Schrötter, *Vorlesungen über die Krankheiten des Kehlkopfes*, p. 271.

[5] Virchow, *Die Krankhaften Geschwülste*, i., p. 441; Bond, *British Medical Journ.*, May 6, 1893; Gerhardt, *Kehlkopfgeschwülste;* Nothnagel's *Spec. Path. und Therapie.*

[6] It is doubtful whether these occur in the larynx, though Cornil and Ranvier (*Histologie Pathologique*, ii.) speak of a diffuse condition there which they call adenoma.

[7] The only reports, without general lymphomatosis, are Wolfenden and Martin's *Studies in Path. Anat.*, Fasc. 2, 26; Jonathan Wright's "Subglottic Neoplasms," *Journ. Amer. Med. Assn.*, Sept. 26, 1891.

[8] Martuscelli, *Archivi Italiani de Laryngologie*, Fasc. 3, 1896; Gerhardt, *loc. cit.*

Glottic spasms, aphonia, and apnea are the graver forms of the same clinical character. Pedunculated growths, by changing their position in relation to the glottis, frequently cause intermittency or exacerbation of these symptoms.

Benign tumors being usually of slow growth, the advent of dyspnea is not noted by the patient, except in the case of pedunculated growths, when it is intermittent or spasmodic, until very surprising encroachment has been made on the air-way. They so gradually become accustomed to interference with respiration that it is not noticed until some sharp attack of inflammation still further blocks the larynx and perhaps produces dangerous choking. The laryngoscope, of course, establishes a diagnosis which, until it is used, is mere surmise.

Treatment.—The treatment of benign laryngeal neoplasms consists in their removal from the larynx or their destruction *in situ*. The method and means employed will depend almost entirely upon the size, shape, and situation of the growth. Small sessile growths can best be destroyed by the galvano-cautery. The various forms of laryngeal forceps, snares, and guillotines are the endo-laryngeal instruments, among which selection must be made for the pedunculated or circumscribed growths. This selection will be largely a matter of the individual preference of the operator. Urgent dyspnea may necessitate immediate tracheotomy. In many cases the tumor may be so large that it is advisable to have tracheotomy-instruments at hand for immediate use, should the emergency of the moment require it during an endo-laryngeal attempt. Rarely, in subglottic or in broad-based hard growths, such as chondromata, a thyrotomy is necessary.

MALIGNANT TUMORS OF THE LARYNX.

Carcinoma of the Larynx.—It is not intended here to treat of those cases of cancer which, originating elsewhere, have spread by continuity or metastasis to the larynx. Such are the malignant growths of the laryngopharynx and esophagus, and of the cervical glands.

In 1889 Semon[1] collected the statistics of laryngeal cancer in such numbers that from the facts given we are able to gather a better and more definite knowledge of malignant growths in the larynx than in any other part of the air-passages. This was due to the interest aroused in the tragic fate of the Emperor Frederick of Germany, and to the unfortunate quarrels of his medical attendants.

Semon's tables show the reports of 107 observers, whose collective experience comprised 10,747 cases of benign growths and 1550 malignant tumors, a proportion of about 7 to 1. Since, as we shall see later, considerably less than 100 reports of laryngeal sarcoma could be collected in 1894 from literature, we may disregard these growths in estimating the relative frequency of carcinoma of the larynx.

As will be seen from his list, Schmidt had himself seen 75 cases. From Semon's tables we find that Störk had seen 100 in Vienna, Oertel 46 in Munich, Massei 39 in Naples, Fauvel 150 in Paris, Semon 56 in London, Cohen 100 in Philadelphia. These are figures given in some cases as estimated, and the number is proportionately larger owing to the numerous cases seen in consultation.

Gerhardt says carcinoma of the larynx is three times more common in men than in women. According to Schmidt's experience it is nearly four times as frequent. Jurasz's own experience was 15 men, 1 woman. He quotes Baratoux's collected statistics as showing 88 per cent. in men.

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[1] *Centralblatt für Laryngologie.*

Jurasz's cases showed it most frequent in the decade from 50 to 60. Gerhardt, quoting Kraus, gives the following table as to age.

20 to 30	4
30 to 40	18
40 to 50	49
50 to 60	76
60 to 70	30
70 to 80	10
	187

Schrötter says he has seen it in a child of three and a half and in a girl of ten and a half years. It has been noted that it occurs more frequently in well-to-do people, and especially in those who use their voices constantly. Heredity seems to have a marked influence in some cases.

The site of growth in Jurasz's cases was as follows:

Whole larynx	1
Right side of larynx	2
Epiglottis of larynx	3
True cords, 1 right, 1 left, 2 both	4
True cords and ventricular bands	3
Arytenoids and interarytenoid space	2
	15

In Mackenzie's 53 cases, however, 28 sprang from the ventricular bands.

Bosworth, quoting from Gurlt, says that out of 11,131 cases of carcinoma it occurred in the larynx in 63 cases, as against 47 in the air-passages above it.

Epithelioma is the form usually observed, but encephaloid, adeno-carcinoma, and scirrhus have all been reported in the larynx. The medullary cancer is more frequently extrinsic and the scirrhus is very rare. Out of 68 cases collected by v. Ziemssen, 57 were epithelioma, 9 encephaloid, and 2 villous tumors; out of Mackenzie's 53 cases, 2 were scirrhus. The usual duration is about three years, but some cases of adeno-carcinoma[1] have lately been reported which lasted five or six years.

Symptoms.—Hoarseness is the first symptom, which usually comes on gradually and lasts for several months before any other symptom supervenes. The majority of the patients are in good general health. The hoarseness, after a longer or shorter time, is accompanied by dyspnea and cough: the former rapidly increases until tracheotomy is urgently indicated. Later in the disease glandular enlargements may be felt in the neck; but they are usually not present at first, although Fränkel reports cases in which the glandular involvement was the most marked feature of the case from the first. Dysphagia sooner or later occurs, and pain, worse at night, robs the patient of sleep. These symptoms are more marked and come on earlier when the ulcerated growth is on the posterior wall or the epiglottis and aryteno-epiglottic folds; but are late when the tumor is on the vocal cords or in the laryngeal ventricles.

The general health deteriorates, the appetite fails, and there is loss of flesh and strength.

Ulceration gives a peculiar and, Fränkel says, characteristic odor to the breath, which is identical with that from a pharyngeal carcinoma. In a recent case of carcinoma of the pharynx, before I realized the source of the odor, the first impression I had of it was that the patient had been using a gargle of the solution of the chlorid of iron on a fetid surface.

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[1] Sokolowski, *Archiv für Laryngologie*, Bd. i., heft 1; Krieg, *Ibid.*, Bd. i., heft 2.

Finally the growth becomes apparent to external palpation, perforating the laryngeal cartilages, which crackle under the finger on pressure. It may even perforate the skin and appear as a fungous mass externally. The last phases of the disease present a most pitiable aspect of human suffering. Tracheotomy has long since become necessary. Granulations block the tube and, growing below it, slowly suffocate the patient. Continual cough, inability to swallow, lancinating pains, and the foul odor make a picture which every laryngologist should have in mind in considering the treatment of the disease in its early stages. Pieces of necrosed cartilage are coughed out, or portions of the tumor may fall into the trachea and bronchi. Perforation of the esophagus frequently supervenes and food may penetrate the bronchial tubes. Hemorrhage is sometimes abundant, although blood is usually only mixed with the copious discharges from the throat. Perforation of the carotid may, however, end the case. Death may come thus, or from exhaustion, or from supervening pneumonia due to penetration of pieces of the growth or food and blood into the lungs—the so-called "Schluck Pneumonie." Suffocation is, therefore, not the only termination of the disease, although it is a frequent one.

Diagnosis.—The *laryngoscopical appearances* of laryngeal cancer must be considered in connection with its differential diagnosis, so far as its initial stages are concerned. Its differentiation from papilloma has already been alluded to. In its incipient stages epithelioma frequently resembles the benign growth. At other times a flat, indolent ulcer on the vocal cord may be seen at the first laryngoscopical examination. When the edges are infiltrated and round we may suspect carcinoma, but sometimes this is not the appearance. The edges may be more or less flat and sharp-cut. Antisyphilitic treatment in decisive doses of mercury and the iodid of potash must be given while a microscopical examination is being made. Tuberculosis must be thought of, and an examination of the lungs for physical signs, and of the sputum for bacilli, must be made.

When the growth occurs in the ventricles of the larynx, the problem is a much harder one to solve. We find a smooth swelling presenting above the cords. Being covered by mucous membrane it is impossible to remove a piece for examination. There is a limitation or entire abolition of movement of that side of the larynx. There is nothing to be done but to try to exclude a syphilitic gumma by the vigorous administration of the iodid of potash. Once I saw such a growth which was evidently tubercular. We must remember that cancer may coexist either with a syphilitic history or pulmonary phthisis. We must also remember that the administration of the iodid of potash may cause a sensible, although temporary, diminution in the size of a cancerous swelling. As Fränkel says, it seems as though the disease was simply catching its breath for a fresh start. The surface finally is involved and the diagnosis becomes evident.

The appearance of the growth, which in the early stages varies so, in the later stages is more uniform and characteristic. The ulcer of cancer then differs in no way from its appearance elsewhere. A fungous mass covered by grayish or whitish secretion fills the larynx more or less completely. The growth eats into the cartilages, causing the swelling characteristic of perichondritis. It has nearly always, even in the initial stages, burrowed more deeply into the underlying tissues than appears on the surface. It grows upward over the top of the larynx, infiltrating the surrounding tissues and producing then marked glandular involvement.

Semon has pretty conclusively settled by his statistics the question of the degeneration of a benign into a malignant growth of the larynx. The exceeding rarity and doubtfulness of this occurrence was one of the assertions of pathologists which clinicians had been loath to accept. In only 45 out of the 10,747 cases reported did this seem possible; while as following upon endo-laryngeal operations it was only reported 33 times. Many of these reports render the opinions expressed extremely doubtful; so that excluding all but the certain cases, Semon's proportion is 1 to 1645 of malignant degeneration after endo-laryngeal operation. And after all, we may say that the proof is necessarily a *post hoc, ergo propter hoc* argument. We must allow the possibility of a benign tumor becoming malignant, although the strongest microscopical proof must be required to admit of its probability in any case.

The **prognosis** of laryngeal carcinoma is, of course, very bad; but the statistics hereafter quoted, it should be remembered, include many cases in which the growth was not confined to the "box of the larynx."

The same rule here holds good, as to the difference in the prognosis of those cases operated on early and those operated on late, as elsewhere in the body; although the cartilaginous walls shutting off the growth from surrounding tissues would seem theoretically to give the incipient cases an especially good prognosis. Without operation all cases die miserably.

Treatment.—Of late years the conviction has grown among laryngologists that every primary intrinsic carcinoma of the larynx in its early stages is a case for extra-laryngeal rather than endo-laryngeal operation. The diagnosis once made, the laryngologist should see *noli me tangere* written in the larynx of every case. No operator, however skilled, can ever be sure that he has removed the infiltrating cancer-cells. There is every reason to believe that cancer is a local disease, which, if disturbed by any operative procedures short of extirpation, is apt to spread rapidly beyond the reach of the knife. Fränkel and Moure both state their belief that the removal of pieces for histological examination does no harm, but that the wound usually heals over. The majority of observers, however, do not agree to this. Doubtless, ineffectual tampering with an already malignant though quiescent growth has, by its results, given rise to the opinion formerly held by some, that such procedures were the exciting cause of a malignant degeneration.

No rules for operation can be laid down that will apply to every case. In a general way it may be said that all cases which are confined to the interior of the larynx and in which there is no glandular involvement are cases for operation by laryngectomy or some of its modifications. Excision, according to Powers and White,[1] has been performed upwards of 300 times. From them I quote the following table, which gives at a glance a general report of the results attained:

1. TOTAL EXCISION OF THE LARYNX.

Cases reported prior to January, 1892	180
Died as result of operation	72
Died in first year, 5 from recurrence	8
Recurred in first year, either dead or living when reported	51
Recurred after 1 year (13 months 2, 2 years 2, 2 years 1 month, 2 years 7 months, 3 years 4 months, 9 years)	8
Reported in first year, free	16
Reported in second year, free	11
Reported in third year, free	3
Reported after 3 years, free	11

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[1] *Medical Record,* March 23, 1895.

2. Partial Excision of the Larynx.

Cases reported prior to January, 1892	77
Died as result of operation (8 weeks)	26
Died in first three years (3 from recurrence)	5
Recurrence in first year, either dead or living when reported	17
Recurrence after 1 year (13 months, 16 months, 17 months)	3
Reported in first year, free	13
Reported in second year, free	4
Reported in third year, free	2
Reported after 3 years, free	7

After what has been said of the course of laryngeal cancer left to itself, it will be admitted that the many cases who died as a result of operation are not to be looked upon as necessarily an argument against the procedure; nor are the cases of complete recovery to be looked upon as unqualified successes. The loss of a larynx is a terrible mutilation of the human organism, and the after-life of the patient, with or without an artificial vocal apparatus, is not an enjoyable existence. Gussenbauer and Wolf have invented mechanisms which permit these patients to produce articulate speech; but many cases have been reported in whom some fold of tissue has been formed by nature to serve as a vibrating membrane in the production of sound and its modification by the lips and tongue into speech.

Cohen's well-known case of adeno-carcinoma, in which the larynx and upper part of the trachea being removed, the remaining tracheal orifice was stitched to the skin above the episternal notch, is still alive (November, 1896)—nearly five years after operation—and he speaks hoarsely, but distinctly, by means of swallowed air which he holds in a kind of a pouch in his pharynx and expels past some vibrating fold of mucous membrane in the neighborhood of the pillars of the fauces. He breathes without cannula through the cervical opening.

Excision of the larynx is an operation which, in fairness to the patient, should only be performed by a surgeon skilled in all the technic of modern surgical methods and equipped by previous surgical experience with the ability and presence of mind to meet grave and often unexpected problems which may arise during its performance. Cohen and especially Semon[1] are the laryngologists who have had the most gratifying results in these operations; but, as a rule, it is not a task to be undertaken by even the experienced laryngologist.

In many cases the tumor has spread, either by direct growth or by metastasis, beyond the larynx. The inclusion of these in the tables given is what makes the percentages of recurrence and death so high. In each case, as it is met, a decision as to a radical operation or a palliative treatment is to be decided on its merits and according to the wishes of the patient, when the conditions are explained to him. Tracheotomy for the passage of air is always indicated, and even gastrotomy for the introduction of food may be a means of prolonging a miserable existence.

Sarcoma of the Larynx.—Bergeat[2] has presented the most complete and exhaustive review of the reports of sarcoma of the larynx yet published. His list is as follows:

Laryngeal sarcoma, primary	85
Laryngeal sarcoma, secondary, by continuity	10
Laryngeal sarcoma, secondary, by metastasis	2
Doubtful	17
	114

Tracheal and bronchial sarcoma, primary	7
Tracheal and bronchial sarcoma, secondary in man	9
Tracheal and bronchial sarcoma, secondary in animal (dog)	1
	17

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[1] Semon (*Lancet*, Dec. 15, 1894, *et seq.*), in a series of private cases, has attained the best results hitherto published.

[2] *Monatschrift für Ohrenheilkunde*, 1895, Nos. 8 and 12.

Reports of the following cases (not included in Bergeat's tables) are at hand:

Chappell,[1] female, aged 32, symptoms 4 years. Sarcoma (perithelioma) of epiglottis, very large, pedunculated, removed with hot snare; weight 360 grains; size $4\frac{1}{2} \times 3\frac{5}{8}$ inches in circumference.

Thompson,[2] male, aged 35, blacksmith, symptoms 6 months, right side of larynx, laryngectomy.

Mackenzie says that he had seen only 5 cases of sarcoma of the larynx. As he had seen 53 cases of carcinoma, we have the ratio in his experience of about 1 to 10. Schmidt's proportion, it will be seen, is 3 to 75 or 1 to 25; while Bergeat quotes Gurlt as giving the general relative occurrence throughout the body as 1 to 13. Bosworth, quoting Gurlt, says that out of 848 sarcomata, the larynx was the seat of disease in only 1 case.

In Bergeat's tables, out of 66 cases of primary sarcoma, 48 were of the male sex and 18 female—in general, he says, sarcoma occurs in men 10 per cent. more frequently. It occurred in men almost twice as frequently (15) from 50 to 60 as in any other decade; the next in frequency (8) being from 40 to 50. The youngest was 7 years old; the oldest 81. In women it occurred from 21 to 53 inclusive, there being 5 each from 30 to 40 and from 40 to 50, and only 2 from 50 to 60. Curiously enough he notes its more frequent occurrence in people who came often in contact with horses.

In variety they were spindle-celled, 22; round-celled, 12; alveolar, 5 or 6; mixed, 4; giant-celled, 2 or 3; fibro-myxomatous, 1.

It had its origin most frequently on the vocal cords, but also occurred in almost every other locality. On the vocal cords and epiglottis the spindle-celled sarcoma was almost the exclusive form found. No instance is recorded in which the growth originated in the larynx and spread to the pharynx; the secondary invasion was always the other way. Erosion and perforation of cartilage were rarely observed. In spite of the numerous observers who have drawn attention to the lateness of glandular involvement in laryngeal carcinoma, Bergeat noted it in 15 per cent. of the cases of laryngeal sarcoma. This was especially marked with the round-celled and alveolar sarcomata. The course of these forms is frequently very rapid; but the duration of sarcoma of the larynx seems to vary greatly, the symptoms sometimes dating back only a few weeks and sometimes running back for several years; some of the cases having lived as long as 7, 8, and 10 years. Pain and dyspnea are not so prominent as in carcinoma, and ulceration is also not so usually observed. The general health is frequently not seriously affected; but there is the greatest variation in the severity of the symptoms.

Diagnosis from carcinoma is usually impossible without a microscopical examination. The same caution must be observed here as elsewhere in distinguishing small round-celled sarcomata from syphilitic and other granulomata. In summing up all the cases, as Bergeat has done, it is seen that the average course and clinical picture differ materially from those of carcinoma, and yet in any given case the differential diagnosis upon these alone is not satisfactory. Bergeat lays some stress on a striking yellow color which is sometimes observed in sarcoma, but never in carcinoma, on the slower growth, the later and more infrequent ulceration. Sarcoma is sometimes pedunculated. There are rarely any sharp-pointed projections, but they are usually round and broad.

Prognosis.—In a general way the prognosis after all methods of operating is better than in carcinoma, one case of total extirpation being well and able to work after fifteen years; and in one case the duration was twenty-one years, during which many endo-laryngeal operations were performed. In the larynx, as elsewhere, there are many cases in which the diagnosis is a matter of considerable doubt, even with microscopical examination.

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[1] *Laryngeal Neoplasms*, case 2.

[2] *The Medical News*, Oct. 26, 1895.

Treatment.—The same indications obtain as in carcinoma.

NEOPLASMS OF THE TRACHEA.

Avellis[1] gives a résumé of the literature of benign tracheal growths. He refers to 17 reports, making with his own about 20 undoubted cases. A few have been reported since 1892.[2]

Many cases are reported of granulation-papillomata and polypi around tracheotomy-wounds, and a few cases are recorded of the projection of pieces of thyroid hypertrophies into the trachea. There are also some reports in which it seems evident that the growths really sprang wholly or principally from the subglottic portion of the larynx. The benign growths were usually papillomata or fibromata. An adenoma and a chondroma have also been noted; but we may be permitted to doubt the nature of these, since the former is so rare anywhere in the air-track and of such a doubtful nature when reported, and chondroma is apt to be confounded with ecchondrosis. Ecchondroses pure or partially ossified have often been noted *post mortem.*

Carcinoma of the trachea is so rare that when Cornil and Ranvier published their work in 1884 they denied[3] absolutely that it ever occurred there primarily. Nevertheless, several had been reported. Ten years later Pogrebinski[4] was able to give abstracts of 13 reports of carcinoma of the trachea, 3 of which he looked upon as doubtful, while 1 was known to have started in the esophagus. To this number he adds a case of his own, an epithelioma primary in the trachea. Many of these cases were of the encephaloid variety. There are a number of other cases reported in which the trachea was secondarily involved from growths in the esophagus and in the thyroid gland. Not included in this list is a doubtful case of Schmidt's and a genuine case described by Oestreich.[5] Another case is referred to in the *Centralbl. für Laryngol.*, viii. p. 396. We have seen that in Bergeat's tables but 7 cases of primary tracheal sarcoma are on record, thus refuting the statement of Koch,[6] that sarcoma is the more frequent malignant neoplasm.

The chief symptom is dyspnea, and when dyspnea occurs from a tracheal growth, that growth always dangerously occludes the air-way. In the upper part of the trachea always, and in the lower part usually, the laryngoscope will reveal the nature of the trouble. The physical characteristics of the growths differ in no way from similar neoplasms in the larynx. A low tracheotomy may gain time for a more extensive opening of the air-tube and extirpation of a benign growth. Many cases of death from it are on record; but endo-tracheal operations are usually impracticable. Malignant growths are almost uniformly unrelieved and fatal; although in Schmidt's case of epithelioma, diagnosticated microscopically by Weigert, the patient was alive two years after operation. Dyspnea without other symptoms usually appears so late that in malignant cases the patients present themselves only when their condition is hopeless. Indeed, many of the reports are from the post-mortem table.

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[1] *Monatsch. f. Ohrenheilk.*, etc., 1892, No. 7, p. 195.

[2] *Centralbl. f. Laryngologie*, 1892, viii. pp. 104–492; 1894, x. p. 100; 1895, xi. p. 134.

[3] Vol. ii. p. 65.

[4] *Revue de Laryngologie*, 1894, No. 12, p. 441.

[5] *Deutsch. med. Woch.*, 1895, p. 34.

[6] *Ann. des Maladies de l'Oreille*, etc., 1890, p. 682.

INJURIES AND DEFORMITIES OF THE NOSE AND THROAT.

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INJURIES of the nose may be considered under the following heads: (1) contusions, wounds, and burns; (2) fractures of the bones and cartilages; and (3) dislocations of the bones and cartilages.

CONTUSIONS, WOUNDS, AND BURNS OF THE NOSE.

Contusions.—Owing to the prominent and unprotected position of the nose, it is subject to frequent injuries. The most frequent of such injuries are contusions caused by falls or by blows inflicted upon the nose with the fist or any hard substance. There is, according to the amount of the impinging force, more or less hemorrhage from the nose, and ecchymosis at the point of injury. When the injury is confined to the upper part of the nose, it is followed by more extravasation of blood into the loose cellular tissues at the base of the nose and around the eyes, and also by much more swelling of the soft parts, than when the injury is confined to the end or lower part of the nose, owing to the firmness of the tissues in the latter region.

Treatment.—When the injury is comparatively slight it, as a rule, gives rise only to moderate epistaxis, from the rupture of the capillaries of the pituitary membrane (usually at the juncture of the bony with the cartilaginous portion of the septum), which generally stops spontaneously. Severe lesions, and sometimes even slight injuries, will be followed by profuse and persistent hemorrhage, owing to the great vascularity of the pituitary membrane, or to a hemorrhagic tendency, requiring the application of pressure, or cold externally, or tamponing of the nose. The simplest manner in which pressure can be applied is by grasping the nose firmly between the thumb and forefinger as close to the face as possible. In this manner hemorrhage from the anterior portion of the nose can be immediately arrested; and at the same time by holding the head forward, so as to allow the blood to gravitate into the dependent portion of the nose, a clot is formed, which will favor the arrest of hemorrhage in the deeper parts.

In severe injuries there may be an effusion of blood between the laminæ of the septum, causing what is termed a bloody tumor, which if allowed to remain until decomposition takes place, will result in abscess of the septum (Fig. 639). This should be incised through the nostril and thoroughly evacuated, and the cavity irrigated with bichlorid solution, 1 : 5000. Gentle pressure should then be applied to each side of the septum by means of a clamp having the arms covered with gauze or aseptic cotton, so as to obliterate the cavity and maintain coaptation until healed.

Wounds.—Wounds of the nose may be divided into incised, lacerated, and punctured wounds, according as they are produced by cutting, blunt or bruising, or pointed instruments. They may affect the soft parts alone; the soft parts and bones and cartilaginous framework; or the soft parts, hard parts, and pituitary membrane. They may also be so extensive as to involve the nasal fossæ, the orbit, and the accessory sinuses of the nose, and even the cranial cavity.

(*a*) *Incised wounds* may vary from a slight cut of the skin to the complete severance of the organ. They may be vertical, transverse, or oblique.

Simple incised wounds of the skin are of importance only so far as they cause disfigurement. In case of vertical wounds the edges of the skin come together very readily and can be easily held in position by adhesive plaster or styptic collodion; whereas in transverse wounds there is more retraction of the parts, which necessitates the uniting of the edges of the skin with fine sutures. Special care must be exercised when the inferior portion and wings of the nose are involved, because the elasticity of the cartilages of the alæ tends to separate the parts, while the functional importance is great.

Transverse incised wounds, involving the deeper structure of the nose, may allow the end of the nose to drop down on the upper lip, held only by the septum and tissues at the base of the nose. In some instances a transverse incised wound may be so extensive as to pass through the nose, involving the deeper structure and the maxillary bones. Larrey reports a case in which with "un coup de sabre" the inferior half of the nose, the corresponding two sides of cheek and upper lip, and the two maxillary bones were divided clear to the palate. The parts were carefully sutured in place, with complete recovery in forty-five days.

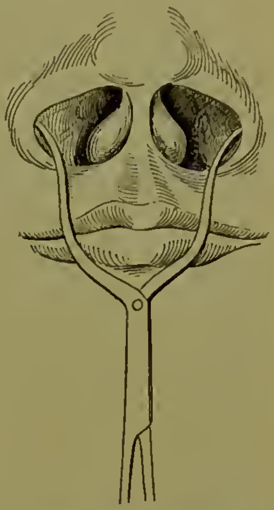

FIG. 639.—Abscess of the nasal septum, showing swelling on both sides.

In other cases the nose may hang by a slender pedicle or be completely severed. A number of cases are recorded in which the union took place when the nose was set on again after it had been severed for several hours. In Cagarlinge's[1] well-known case it was detached five and one-half hours, and in Garenot's case the severed end, which had been bitten off, was recovered from the sewer into which it had been thrown. It was cleansed with warm water, reapplied, and on the fourth day was quite firmly united. In all cases, even if a number of hours have elapsed since the accident took place, attempts should be made at the restoration of the part by carefully cleansing the detached parts with warm sterilized normal salt solution, and scarifying or scraping the raw surface to encourage its attachment.

Galin and Hoffacker claim an advantage in waiting a short time before restoration of the severed end by reason of there being a complete arrest of hemorrhage. The surfaces can be thoroughly cleansed, and the danger of formation of blood-clots between the surfaces will thereby be avoided. In attaching the severed portion the soft parts, including the cartilaginous portion, should be carefully stitched together, and the interior of the nose should be tamponed with antiseptic gauze to protect the parts from the inside and to maintain the nostrils in their normal form. The union, as a rule, takes place slowly; the end may remain cold and pale for twelve hours or even two or three days, and therefore we must not be in haste to regard the operation as a failure.

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[1] *Traité des Operations de Chirurgie*, 1724, Chap. iii., Art. 2, Obs. 6.

(*b*) *Lacerated wounds* are usually produced by blunt instruments, falls on angular or rough surfaces, projectiles, etc. Wounds from blunt instruments are usually attended with a fracture or dislocation of the nasal bones.

In case of projectiles, where a bullet comes from a lateral direction, it usually passes through the nose, involving both walls; but in case of spent bullets they may penetrate only one wall of the nose and lodge in the meatus, the orbit, in an accessory sinus, or they may penetrate the brain. In some cases the wad of a gun may be forced into the wound with the bullet and remain there as a foreign substance. In one case reported by Legouest, the wad of a gun was found astride of the septum. The skin cicatrized after its introduction and the accident was forgotten. There was a continuous fetid discharge from the nose, and after four years the wad was discovered during a rhinoscopic examination and removed. The treatment of lacerated wounds of the nose requires especial care to render the parts aseptic and to coaptate the skin and maintain the normal contour of the nose, as far as possible.

(*c*) *Punctured wounds* are produced by sharp-pointed instruments. In some cases the instrument or foreign body may enter through the nasal fossæ and penetrate the cranial cavity through the cribriform plate of the ethmoid bone, without external manifestation of the injury. Punctured wounds of the base of the nose are frequently followed by emphysema of the soft parts, owing to the looseness of the connective tissue in this region. This takes place most frequently when the penetrating wound of the nose communicates with the nasal cavity, and the emphysema is caused by the air being forced through this opening under the skin when the patient blows his nose, or during forcible expiration through the nose. It accordingly appears quickly, giving the sensation of a sharp, hot streak as the air is forced under the skin. It may be limited to the superior part of the nose, where the cellular tissue is quite loose, or it may extend to the eyelids, and sometimes to the neighboring portion of the face. Slender instruments, or such foreign bodies as knives, pencils, and the like, may penetrate the walls of the nose and break off, remaining in the wound.

Treatment.—Simple punctured wounds of the external nose, as a rule, require only ordinary antiseptic care. In complicated cases, however, in which the end of the instrument has broken off and remains as a foreign body, it must be extracted either through the wound, from the interior of the nose, or removed through an artificial opening, and the wound afterwards treated as an incised wound. Each case, however, must be treated according to the peculiarity of the conditions found. The emphysema of the face which sometimes accompanies punctured wounds of the nose usually subsides in a short time, although the disappearance can be hastened by poultices and compression.

Burns and Scalds.—Burns and scalds of the nose do not differ in their nature and treatment from burns and scalds of other portions of the body. They are of special significance only so far as the resulting cicatrices cause distortion of the organ and contraction of the nasal passages. It is therefore during the healing process of the burn or scald that we should give particular attention to prevent any such complication.

The contraction of the burn can be overcome in a great measure by resorting to skin-grafting before the wound is healed, thereby replacing the skin that has been destroyed and preventing the formation of cicatricial tissue, by which the edges of a wound are forcibly drawn together. Special care should be taken in this particular when the nasal orifices are involved. Ivory or vulcanite plugs or tubes should be inserted into the nostrils to keep

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the nasal openings widely dilated, until all tendency to contraction of the tissues has passed. When, however, this contraction of the tissues has taken place and the nasal orifices have become greatly narrowed, the treatment to be adopted is described under the head of Stenosis of the Nasal Passages.

FRACTURES OF THE BONES AND CARTILAGES OF THE NOSE.

Fractures and dislocations of the nose may vary, according to the severity of the injury, from simple displacement of some one of the bones of the nose, without wounding the skin, to compound comminuted fracture of the bones, attended with more or less destruction and escape of the bony fragments, resulting in marked distortions and permanent disfigurement of the nose.

Fractures of the bones of the nose are comparatively rare when we consider the prominent and exposed position of the nose and the frequency with which bodily injuries occur. This is accounted for somewhat by the yielding condition of the cartilaginous portion of the nose, which more or less resists fracture, and the arched form of the osseous portion or bridge of the nose, which enables it to withstand a considerable amount of external force. The nose is also in many cases protected by the prominence of the frontal bone.

Fracture of the nose is more frequent in men than in women, and also more frequent in adults, owing to the cartilaginous and more yielding character of the parts in the young.

Fractures of the nose always result from force applied externally, oftenest in the form of blows or falls directly on the nose. They are usually attended with lesions of the integument, and are frequently associated with fractures of the nasal process of the superior maxilla, together with dislocation or fracture of the nasal septum. In severe injuries the osseous portion of the nasal septum, together with the nasal bones, has been driven backward into the brain.

Such injuries are usually attended with severe hemorrhage and escape of cerebral matter, with all the symptoms of fracture at the base of the cranium, and are generally fatal.

Fractures of the bones of the nose are almost always bilateral, unilateral fractures being rare. In some cases, when the force is applied entirely to one side, fracture of the bone on this side may be attended with dislocation of the bone on the opposite side, together with lateral dislocation of the nasal septum, as represented in Fig. 640.

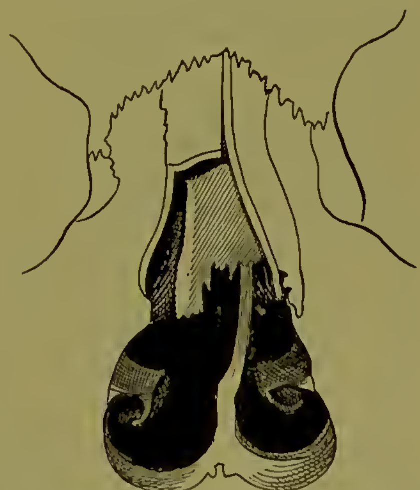

FIG. 640.—Fracture of the right nasal bone and displacement of the left, with lateral dislocation of the nasal septum.

Fractures of the nose may be divided into *simple*, *comminuted*, and *compound*. In simple fractures of the nose the line of the fracture may be vertical, oblique, or transverse, according to the direction of the blow. In vertical fractures one fragment may slide under the edge of the other, the latter protruding sufficiently to form a ridge readily felt by the finger. In oblique or transverse fractures the lower fragment is depressed; the upper fragment remains unbroken and, accordingly, maintains its normal position.

In a comminuted fracture the fragments are more or less numerous, and in case it is compound they may escape through the wound and thereby be destroyed and lost. Simple fractures may exist without any resulting disfigurement; whereas comminuted or compound fractures may be followed by narrowing and obstruction of one or both nasal passages, and of one or both lachrymal ducts, causing lachrymal tumors and stylliciduim.

The *lachrymal bones* may be fractured by a slight or very moderate blow, accompanied by discoloration of the eyelids; and sometimes emphysema of the cellular tissue of the orbit may take place, on blowing the nose, by the escape of air from the nostrils through the fractured edges of the bone.

Diagnosis.—The diagnosis of fractures of the nose in some cases is extremely simple, whereas in other cases it is attended with great difficulty. Simple fractures of the nose may exist without displacement of the fragments, the latter being held in place by the periosteum, the soft parts, and the mucous membrane. The line of the fracture can often be felt under the finger as a slight fissure. In other cases it is manifested only by pain in the seat of the injury. When there is displacement of the fragments the protruding edges of the fracture form a ridge, which is not only readily perceptible to the finger, but can be seen on inspection. In order to determine the extent of the fracture and the condition of the part, the examination should follow the injury as speedily as possible, for the swelling of the soft parts so quickly supervenes as to make the diagnosis very difficult.

Vertical fractures can be detected by the careful movement of the lateral fragments against the edges of the unbroken portion. In oblique or transverse fractures, since the lower fragment becomes depressed, the edge of the unbroken portion is prominent. Often, in making a rhinoscopic examination, the depressed portion of the bone can be seen projecting into the interior of the nose. In comminuted fractures the crepitation of the fragments is generally readily detected, but great care should be exercised when making the examination not to increase the displacement. In compound fractures the condition of the bony parts can be easily discovered by exploration with a probe through the wound. When the contused parts have become greatly swollen before the patient comes under observation, it is then usually necessary.to wait until the inflammation and swelling have been reduced, before the exact condition of the part can be made out.

Two of the most prominent symptoms of fracture of the nose are epistaxis and emphysema of the tissues of the nose. Emphysema of the nose is indicative of rupture of the mucous membrane, through which opening air is forced into the tissues. It usually comes on rapidly when the patient blows his nose, as in the case of punctured wounds. It is generally limited to the region at the base of the nose; although it may extend to the periocular cellular tissue (sometimes completely closing the eyes) and throughout the face. In exceptional cases it may involve the tissues of the neck. It is detected by crepitation, much as given by the edges of the broken bone. Epistaxis, which is almost always present, varies according to the extent of the injury, and may be very slight or very profuse, although it is never sufficient to endanger the life of the patient. It usually ceases spontaneously, although in severe cases tamponing the nose may be necessary to prevent weakening the patient from loss of blood. In these cases the presence of hemorrhagic exudates, which may accumulate between the hard and soft parts, should be recognized and evacuated to prevent purulent formations or septic infection and the breaking-down of the lacerated tissues.

In all cases of fracture of the nose the gravity of the case depends entirely upon the brain-complication. The secondary complications which may follow these injuries are deformities of the nose, injury to the lachrymal apparatus, impairment of the sense of smell (either from occlusion of the nasal passages or injury to the olfactory nerve), and lack of resonance in the voice, owing to the contraction of the nasal passages.

Treatment.—In all cases of fracture of the nose the replacement of the fragments should be effected as speedily as possible, before swelling of the parts has supervened to prevent it; for when the swelling is extensive it is frequently necessary to wait until it subsides before the fragments can be replaced. This can usually be delayed for three or four days with perfect safety, although if the case is seen early, much of the swelling can be prevented by attention to antiseptic and antiphlogistic measures.

In case the fracture is a compound one, we should attend carefully to the wound of the skin (as in case of lacerated wounds of the nose) in order to prevent, as far as possible, disfigurement from resulting scars. Laceration of the mucous membrane should also receive attention and be rendered, as far as possible, aseptic.

In simple fractures the reduction is best accomplished with a smooth sound, placed in the interior of the nostril to raise the depressed fragments, and their coaptation is facilitated with the fingers on the outside of the nose. When no sound is at hand and the nasal passages are sufficiently large to admit the little finger, it can be very advantageously substituted. In some cases the fragments are best and most easily adjusted by means of a pair of smooth-blade forceps, one blade placed in the nostril and the other outside, according to the plan of Weber, care being exercised not to use too much pressure; and to avoid lacerating the tissue the blades can be covered with rubber or adhesive plaster. For this purpose Mollière uses forceps with ivory blades. When the septum has at the same time become fractured or dislocated, it also should be put in place.

When the fragments have been replaced, they must be held with some form of retentive apparatus. If the skin is unbroken, a piece of rubber adhesive plaster, cut of the shape to completely cover the nose, has been found by the author to be one of the most important aids in rendering the exterior contour smooth and symmetrical. This is to be covered with a metallic form (Fig. 641), made

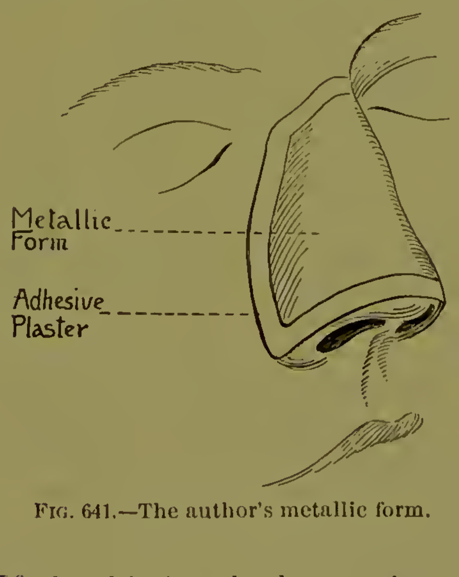

FIG. 641.—The author's metallic form.

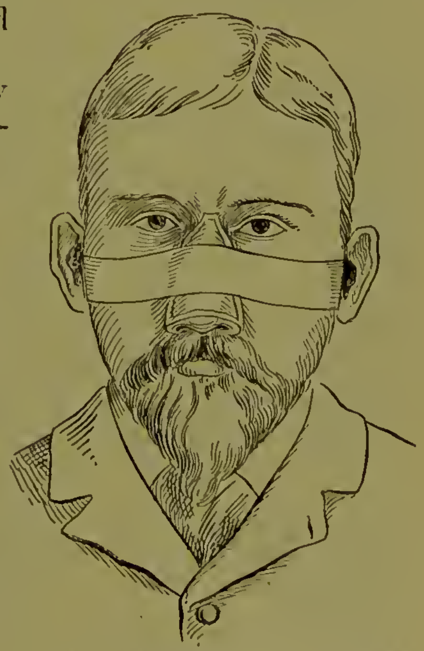

FIG. 642.—Metallic form and adhesive plaster as applied.

of a sheet of aluminum cut the requisite size and shape, so that when bent the internal contour is the same as the normal nose, and of sufficient size to rest lightly over the nasal border of the superior maxilla. Before this form is applied to the nose, I usually cover and line it with adhesive plaster, which materially assists in holding it in place. It is then adjusted to the nose and securely held in place with adhesive straps, as shown in Fig. 642.

Various other methods have been devised for maintaining the fractured nasal bones in place. Thus Malgaigne has used moulds of lead, which have the disadvantage of being heavy. Hamilton uses gutta-percha, but it is not readily adjusted to the desired shape of the nose. Weber employs strips of gutta-percha, maintained in place by plaster. Dumreicher employs successive collodion bandages, applied to the nose. Walsham uses a mask of leather, moulded to the face with braces controlled by screws, to maintain the bones in place. Adams has devised a nasal truss attached to a headband, which is buckled firmly around the head, with a padded arm controlled by screws resting against each side of the nose to hold it in position, as shown in Fig. 643. None of these methods, however, has given me the satisfactory results obtained by the simple method which I have described.

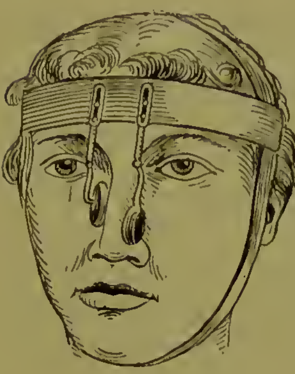
FIG. 643.—Adams's nasal truss.

Numerous internal supports have also been employed for holding these bones in position after the deformity has been corrected. Hamilton packs the nose with pledgets of lint, to each of which is attached a thread for ready extraction. Packard employs plugs of hard rubber, placed inside the nostril. These methods have their advantages since no one plug large enough to maintain the bones in place can be introduced through the nasal apertures. For the purpose of maintaining the vault of the nose, Mason, of Brooklyn, has devised a method of transfixing the nose with nickel or gold needles through the base, on a line with the maxillary junction. He then passes under the needles and over the nose a bandage of rubber. This is efficient to prevent spreading at the base of the nose, and at the same time to hold the nose snugly together and prevent depression of the vault. This is considered an exceedingly ingenious arrangement, and may be of service in some cases. After the parts have become solidified, at the end of seven or eight days, the needles are removed. Many discourage the employment of internal supports, because of the irritation which they cause. This objection is ill-founded, for the reason that the irritation is invariably due to the excessive amount of pressure employed. Very slight pressure only is required to maintain the parts in position, because they are naturally immovable and there is no muscular tension to cause their displacement, nor any other force when the nose is thoroughly protected by a uniform external support. The fragments can most easily be maintained in place by means of an elastic spring placed in the nostril, the tension of which is regulated by means of a screw on the outside, as shown in Fig. 644.

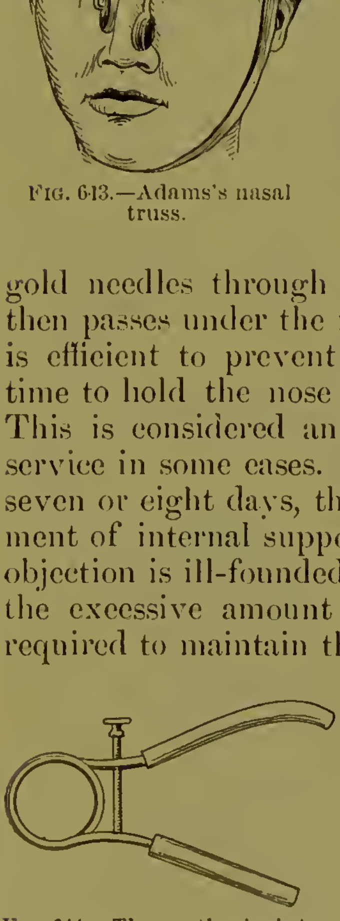
FIG. 644.—The author's intranasal spring.

Before the spring is inserted the interior of the nostril is carefully irrigated with an antiseptic solution and dusted with iodoform or some other strong antiseptic powder.

After the bones have been put into place a portion of iodoform-gauze is made into a roll that will just fit the upper portion of the nasal cavity, and forced up into the vault sufficiently to hold the fragments in place in perfect coaptation with the external metallic mould that is placed on the outside of the nose. (In many cases, however, it is better to insert the internal support before the metallic form is applied.) Under this gauze is placed the upper arm of the spring, the lower arm resting on the floor of the nose. The spring should be made of the proper size and shape to fit the interior of the nose; while the tension exerted is regulated by a screw at the lower end of the spring. The pressure in these cases should be just sufficient to support the part without causing pain. The lower arm of the spring is covered with rubber tubing, to prevent irritation of the soft parts. By this method the lower respiratory passage remains unobstructed, so that nasal respiration is not materially interfered with. The interior of the nose also can be kept clean by frequent cleansing with an antiseptic wash, until the fragments are united and the nose is self-supporting.

In those cases in which the fractured bones are allowed to go unreplaced until firm union has taken place, re-fracture of the bones becomes necessary in order to restore them to their normal position. This operation will be described under deformities of the nose.

Fracture of the Cartilages of the Nose.—The lower portion of the nose is composed of two lower lateral shield-cartilages, united in the center. These shield-cartilages are connected with the nasal bones above by two upper lateral cartilages, which maintain the contour of the central portion of the dorsum of the nose, as shown in Fig. 645. In cases of moderate injuries to the nose these cartilages are rarely fractured; but when the injury is severe, particularly if inflicted by a more or less sharp body like the sharp edge of a board, fracture of the cartilages sometimes takes place. This is especially true of the upper lateral cartilages, which maintain the contour of the dorsum of the nose. Fracture of the shield-cartilage is readily detected by the resulting deformity and by the crepitation which can be elicited by careful manipulation; but fracture of the upper lateral cartilages is frequently so obscured by the attending swelling and inflammation that it is undetected, and only manifested by the resulting depression and deformity of the nose that follow after the inflammatory symptoms have subsided.

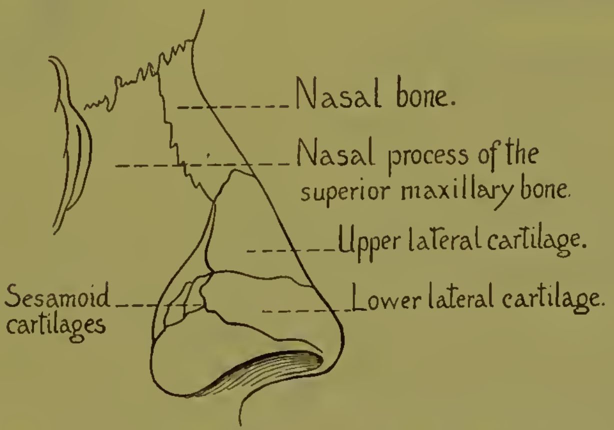

FIG. 645.—Profile view of the bony and cartilaginous constituents of the nose.

Treatment.—In many cases of fracture of the shield-cartilages the fragments are best held in place by means of the spring above described. When the fracture is in such a position that this cannot be readily maintained in place, a strip of vulcanite or celluloid can be moulded with heat and made to fit the nostril so as to maintain it in its normal position until the fragments are united. Perforated cork-splints are also especially serviceable on account of their lightness and the readiness with which they can be fitted to the contour of the nostril. When these are not at hand the nostrils can be packed with antiseptic gauze, so as to maintain them in their proper form. It is advisable, however, to insert through the center an open tube for respiration (see Figs. 573, 574).

Fractures of the Nasal Septum.—The nasal septum being composed of three pieces, as shown in Fig. 646, and as each one of these pieces may be fractured independently, we therefore can divide fractures of the septum into three groups: as the fracture of the triangular cartilage, of the vomer, and of the perpendicular plate of the ethmoid.

The portion most frequently fractured is that of the triangular cartilage; it is always the result of traumatism. Fracture of the cartilage alone may take place as an independent lesion or it may be associated with dislocation of the cartilage at its attachment with the vomer, as shown in Fig. 647. Fractures of the cartilage are also frequently associated with hematoma, which is bilateral; the bloody tumor filling both nostrils, communicating through the fissure in the septum. Separation of the cartilage may take place from displacement of the fragments, although they will more frequently be found overriding each other. The diagnosis of this accident is important, as the integrity of the nose depends on its recognition and proper treatment. When there is no displacement it can be recognized only by the attendant pain, the greater mobility of the structures associated with swelling of the soft parts, and the fissure can be found by exploration with a probe. The crepitus can be found by careful manipulation of the parts. Displacement of the fragments is manifested by depression of the end of the nose, which is distorted to one side, producing a double deformity. Sometimes the end of the nose is flattened on the face. When the fracture is compound it is accompanied by more or less epistaxis, and sometimes by subcutaneous emphysema.

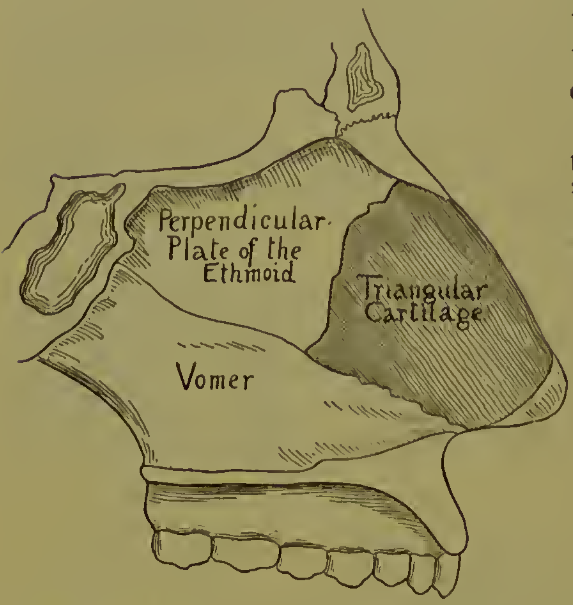

Fig. 646.—Bones and cartilage of nasal septum.

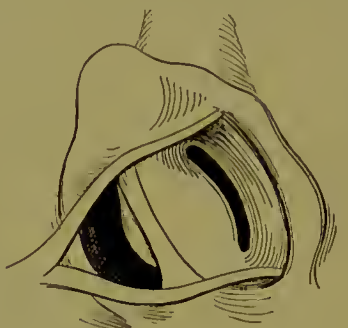

Fig. 647.—Dislocation of the triangular cartilage.

Fracture of the vomer alone is a rare accident, and from its situation and position displacement of the fragments does not readily take place; the line of the fracture can, however, be detected by a careful exploration with a blunt-pointed probe, and on inspecting the nostril with the aid of a strong light it can sometimes be recognized by a hemorrhage-point.

Fracture of the perpendicular plate of the ethmoid is usually accompanied by comminuted fractures of the bones of the nose, although substances penetrating the nasal cavity have been known to fracture this bone alone. The cribriform plate may also be fractured and the foreign body at the same time enter the cranial cavity, the latter being always a very serious accident. When the fracture of the perpendicular plate exists alone it is usually at a point on a level with the vomer.

Treatment.—When there is displacement of the parts, they should be first put in place by means of a pair of forceps with flat parallel blades, one blade being inserted into each nostril, and by gentle pressure the bones can then be restored to their normal position, aided by gentle manipulations. When there is displacement of the fragments to one side it is frequently necessary to insert an internal support only on that side; and when there is laceration of the mucous membrane also on that side of the septum, the best form of support is made by winding sublimate cotton around a metallic plate from 1½ to 2 inches in length and of sufficient size to be inserted in the nostril, the nostril being first, however, irrigated with bichlorid solution, 1 : 5000, and dusted with iodoform. Other forms of support are frequently used for this purpose, as tubes made of hard rubber, of soft rubber, of cork, or of metal, each of which is excellent in cases to which it is adapted; but in cases where it is necessary to maintain the support only on one side, leaving the other nostril free for respiration, the cotton plug, having a metallic core to stiffen it for insertion, is preferable to all others. In cases in which it is necessary to maintain support on both sides a cotton plug can frequently be inserted in one nostril and a tube in the other.

DISLOCATIONS OF THE BONES AND CARTILAGES OF THE NOSE.

Dislocation of the nasal bones is an accident of comparatively infrequent occurrence, and always occurs as the result of blows against the nose, usually from a lateral direction. According to Marchant, dislocation of the nasal bones was recognized by Heister in 1770 and by Bell in 1796; but the first published example was by Bourguet in 1851, and later by Longuet in 1881. In Bourguet's case, a man, twenty-two years of age, was thrown against a sidewalk, striking on the left side of the nose. The upper third of the nose was deviated to the right, the lower end remaining normal. The elevation, which was a dislocation of the nasal bones, was reduced by introducing the ring-finger of the right hand into the nostril and exerting pressure on the outside, when the bone slipped into place and the dislocation did not recur. No deformity of the nose resulted.

A similar case recently came under my observation. A young lady, twenty-two years of age, was thrown from her carriage, striking on the right side of her face, injuring the nose quite severely. There was considerable swelling of the nose, but no crepitation and no fracture of the bones of the nose could be detected. The patient was very ill for a short time as a result of the accident, and it was feared that concussion of the brain had taken place. On her recovery, both nasal bones were found dislocated to the left and the nose was quite crooked; the right nasal bone was depressed, while the left nasal bone was thrown outward and upward, overriding the right, as shown in Fig. 640, forming a hump on that side. As the accident occurred four years before I saw her the deformity was permanent, but was corrected by me according to the methods that will be described in the section relating to deformities of the nose.

In another case, a little girl about five years old, while coasting, was thrown from her sled, striking her nose against the edge of an iron railing, which drove the central portion of the nasal bones backward, dislocating them outward and leaving the nose in a flattened condition. Before surgical aid was secured the swelling of the nose so masked the injury that it was allowed to go uncared for. This resulted in a permanent flattening of the central portion of the nose and a bulging outward of the nasal bones.

Dislocation of the bones of the nose can readily be detected, *first*, by the deformity of the nose, and *secondly*, by the elevation of the dislocated edges, which can be felt as a ridge under the finger. The amount of dislocation varies usually with the amount of force exerted against the nose. There may be simple dislocation of one of the nasal bones, or all the various bones of the nose may be more or less dislocated to one side. In these cases the dislocation to one side is usually associated with fracture of the other, as shown in Fig. 640, against which the impinging force came. In some instances the cribriform plate of the ethmoid is fractured, and may be driven upward into the base of the brain.

Treatment.—The reduction of dislocations of the nasal bone is most easily accomplished by placing a smooth sound in the interior of the nose, and by gentle manipulation with the finger on the outside the bone can ordinarily be slipped into place. In some cases, especially if the nostril is large, the little finger can be passed into the nasal chamber and the depressed bones elevated, as in case of fracture of the nose. In this manner, with the thumb or finger on the outside of the nose, the dislocation can be reduced with great precision, as we are enabled by the sense of touch to detect the exact position of the bones. Usually there is no tendency for the dislocation to recur, owing to the lack of muscular tension on the part; but it is far better to apply a retentive apparatus to guard against such a possibility. This is best done by covering the whole of the nose with a piece of adhesive plaster, cut to fit, and by placing on the outside an aluminum form of the proper size and shape for the requirements of the nose, according to the plan described for the retention of fractured nasal bones. This is to be worn a short time, until the inflammation and swelling have subsided and the bones are firmly fixed in position.

Dislocations of the cartilages of the nose may be divided into dislocation of the external cartilages of the nose and dislocation of the internal or triangular cartilage forming the anterior portion of the septum.

(*a*) *Dislocation of the external cartilages* of the nose usually takes place from blows inflicted on the dorsum of the nose. Owing to their elasticity and firm attachment the shield-cartilages are rarely dislocated, but the upper lateral cartilages filling the dorsum of the nose are more subject to injuries and more frequently dislocated. Owing to the smallness of these cartilages and the swelling which masks the injury the dislocation frequently passes unnoticed until it is recognized by the depression of the dorsum of the nose, after recovery from the injury, as shown in Fig. 648. This accident can be recognized and properly treated only directly after its occurrence and before swelling of the soft parts takes place, when the depression and the lack of support of the dorsum of the nose can be readily detected. The cartilage can then be forced into place and held there by gauze packed into the interior of the nose at this point, supported by the spring

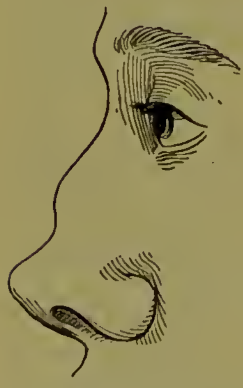

Fig. 648.—Depression in the dorsum of the nose from dislocation of the upper lateral cartilage.

described on page 1122, Fig. 644, together with adhesive plaster applied to the exterior of the nose.

(*b*) *Dislocation of the triangular cartilage* of the septum is of frequent occurrence. It takes place most often in children as the result of a fall upon the nose. In older persons it may result from a fall, blows upon the nose, or various accidents. The dislocation most frequently found is that at the juncture of the triangular cartilage with the perpendicular plate of the ethmoid. It consists in the sliding backward of the cartilage to the side of the bone, giving the septum the appearance of being deflected to that side, as shown in Fig. 647. Since the posterior portion of the cartilage is thrown to one side, the anterior portion is naturally turned in the opposite direction, so that both nostrils are obstructed. There is often also dislocation of the lower border of the cartilage at its junction with the vomer, and also of the vomer at its juncture with the superior maxilla, projecting into the meatus on the side on which the dislocation takes place. This condition is readily detected by anterior rhinoscopic examination, and should be differentiated from ecchondrosis and other pathological conditions which frequently obstruct the nostrils. It is also readily seen that the convexity on one side is proportionate to the concavity on the opposite side. The perpendicular plate of the ethmoid is very often deflected to one side, together with the triangular cartilage; but its dislocation alone can only result from great external violence or from foreign bodies penetrating the nasal chamber.

Treatment.—This dislocation, if recent, can easily be put into place with the fingers, one finger being inserted in each nostril and the parts held there by a tampon placed in the nostril into which the dislocation took place. In other cases the dislocation may be reduced by the use of a smooth-bladed dressing-forceps, or the blades of an ordinary forceps covered with adhesive plaster to prevent wounding the soft parts. When the dislocation has become firmly fixed it can only be reduced by loosening the cartilage along its lower and posterior border. The parts are then forcibly put into position, and held there by a retentive apparatus. The success of the operation depends entirely upon the thoroughness with which the cartilage is loosened from its attachments, thereby preventing the tendency to return to its former position. In some cases it may be expedient to dissect out any redundant cartilage through a small incision made in the overlying tissue, reuniting the edges with fine sutures.

FOREIGN BODIES IN THE AIR-PASSAGES AND ESOPHAGUS.

Foreign Bodies in the Nose.—Foreign bodies found in the nose may be either animate or inanimate. They may be introduced from without or formed within the nose, as in the case of calcareous concretions termed rhinoliths.

Animate foreign bodies, such as leeches, flies, worms, etc., sometimes find their way into the nasal cavity; and other living creatures, such as maggots, may develop from the ova of flies deposited there; this more frequently occurs in tropical countries.

Inanimate foreign bodies may enter through the anterior nares, through the posterior nares, or through the walls of the nose.

Those that enter the anterior nares are chiefly such substances as beads, peas, stones, buttons, fruit-stones, pieces of wood, coins, and, in fact, nearly every substance that it is possible to crowd into the nostrils may sometimes be found there. They are, however, usually introduced intentionally by mischievous children, lunatics, or hysterical women.

Substances that enter through the posterior nares are generally such as teeth, rings, fruit-stones, pieces of bone, etc., which have previously been swallowed and afterward expelled from the stomach and thrown forcibly into the nares during emesis. Substances, such as pieces of cotton and portions of sponges left after plugging the posterior nares, are sometimes found there acting as foreign bodies.

Foreign bodies that enter through the wall of the nose are usually spent bullets, fragments of stone from blasting, or of iron from the bursting of guns. Splinters of wood forced through the walls of the nose have been extracted from the nasal cavity.

Symptoms.—There is usually a more or less profuse sero-mucous discharge from the nose, or if ulceration has taken place the discharge becomes muco-purulent and bloody, and is more or less fetid. There is also more or less obstruction, according to the size of the body, and a swollen condition of the mucous membrane, sometimes attended by frequent attacks of sneezing and neuralgic pains of the face. In the case of peas, beans, etc., much pressure may be caused by the swelling of the body, and sometimes germination takes place.

Living bodies, such as maggots, termed in India "peenash," cause intense pain in the nose and frontal region, of a throbbing character, attended by a sensation of formication. There is swelling and edema of the face, eyelids, and palate, and epistaxis is usually present. Abscesses may form in the nose and destruction of bone may take place, leading to meningitis.

The **diagnosis** of foreign bodies in the nose is usually not difficult. If there is no history of the accident, which at best is unreliable, the occurrence of a unilateral fetid discharge from the nose should lead us to suspect the presence of a foreign body, especially in children. In adults it must be differentiated from syphilis and from disease of an accessory sinus, from which the discharge is almost always unilateral, and from sarcoma or carcinoma. If it is large and located in the anterior portion of the nose, a foreign body may be suspected by a bulging of the ala.

The question can ordinarily be very easily decided with the probe. In children a few whiffs of chloroform are advisable to quiet their fears; but in adults the use of cocain is all that is necessary, both for diagnosis and extraction.

The **treatment** of foreign bodies in the nose consists simply in their removal, although, as Mackenzie observes, there is no occasion for undue haste. Before this is attempted, therefore, their nature, situation, size, and fixedness should be determined.

Animate foreign bodies, such as insects and maggots, are best removed with chloroform. In fact, chloroform is the only effectual remedy. It should be diluted one-half with water, on account of the pain caused in using it full strength. It is then agitated and injected at once before the water and chloroform separate. This was discovered by Dauzat, an apothecary's assistant in Mexico, in the year 1805. The vapor alone will sometimes cause a discharge of the maggots. If necessary to use it full strength, the dilution being ineffectual, general anesthesia should previously be produced with the vapor, as suggested by Mackenzie, to prevent the intense suffering.

Inanimate foreign bodies when lying somewhat loosely in the cavity are readily extracted with a pair of mouse-toothed forceps; but when more or less embedded in the tissues they should be carefully raised from their bed by a suitably curved probe. Sometimes the use of sternutatories, a forcible blowing of the nose, or the use of Politzer's bag in the opposite nostril will cause the foreign body to be expelled. In some cases the method of Sajous will succeed where others have failed, which is by drawing a cotton or wool tampon through the nasal passage from behind.

When a foreign body is impacted in the nose it may be necessary to break it up by means of strong forceps, or by sawing it in two, or by drilling it.

When a foreign body is lodged in the posterior nares it can generally be forced down into the pharynx with a sound introduced through the nose, care being taken that it is not inhaled into the larynx or trachea, or swallowed.

Rhinoliths, or Nasal Calculi.—These consist in the deposition of the salts of the secretions of the nasal passages forming more or less solid bodies, usually having for their nucleus some foreign substance which has been introduced from without. Occasionally they form around some inspissated secretion, favored by a gouty diathesis. They enlarge slowly by accretion of the earthy salts to the surface, being composed mainly of phosphate of lime and magnesia, or chlorid of sodium, carbonate of lime, magnesium and sodium. They may attain considerable proportions, completely filling the naris, sometimes distending it like a foreign growth. From one patient I removed a rhinolith weighing 40 grains, having for its nucleus a small pledget of cotton. They are usually single, though in some cases there may be two or more. They are almost invariably unilateral. Their slowness of growth and the absence of history of the introduction of a foreign substance may cause them to remain undetected for a considerable period, the discharge, as in the case I have mentioned above, being regarded simply as catarrhal. The condition with which they might most easily be confounded is necrosis of the bones of the nose as a result of syphilis.

Their attending symptoms, diagnosis, and treatment are practically the same as that of an inorganic foreign body in the nose, with which they are to be classed.

Foreign Bodies in the Larynx and Trachea.—Foreign bodies entering the air-passages may be either fluid or solid. Fluid foreign bodies comprise articles of liquid food and drink, pus from a ruptured tonsillar, retropharyngeal, or aryteno-epiglottic abscess, blood entering during surgical operations or after an injury, and chyme or other vomited matter.

Solid foreign bodies comprise almost every conceivable substance that can possibly enter or pass through the larynx, and include both animate and inanimate bodies.

Among the most curious and interesting cases of animate bodies may be mentioned fish, held in the teeth during extraction of the hook, leeches entering while drinking water from pools or brooks, lumbricoids transferred from other parts of the body, flies inhaled while riding through them, and the epiglottis of a young woman which became impacted in the larynx while eating. The inanimate bodies that most frequently enter the air-passages are fruit-stones, pebbles, grains of corn, beans, coins, buttons, and the like.

The mode of entrance of foreign bodies may be either through the mouth, through the neck or chest-walls by fistulous openings, or from other portions of the body.

The entrance of substances into the air-passages through the mouth generally occurs during mastication and deglutition, while the person is laughing or talking, or during sleep. Many cases of sudden death are reported where large pieces of meat or other substances have entered the larynx while eating, and caused immediate death from strangulation. Substances held in the mouth are sometimes suddenly drawn into the larynx while laughing or during a fright, or during any condition which causes a sudden inspiration. Such substances as blow-gun darts, whistles, and the like are sometimes drawn into the larynx while the person is amusing himself with these substances. In some instances the substance becomes lodged in the pharynx during sleep. This occurs most often in children who go to sleep with toys, coins, buttons, etc., in their mouths. One of the most interesting cases of this kind is reported by Johnston, where a toy locomotive was inhaled into the larynx of a child during sleep, requiring thyrotomy for its extraction (Fig. 649).

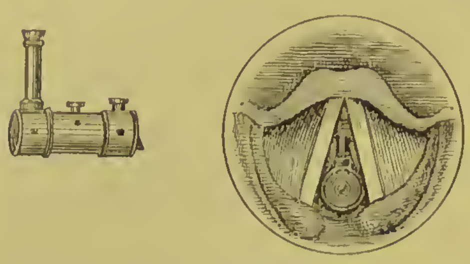

Fig. 649.—Toy locomotive in the larynx (Johnston).

In adults one of the most frequent substances to enter the larynx is a tooth-plate which has not been removed before retiring. Schwetter reports a case where the patient was not aware of the accident until he missed his teeth in the morning. Corks held between the teeth during the administration of anesthetics, and sponges used about the mouth during operations, have been drawn into the larynx.

Substances entering through the neck or chest-walls are most frequently flying fragments from explosions, bullets, and other projectiles; and portions of ill-constructed tracheotomy-tubes, not properly cared for and allowed to corrode, may become detached and fall into the trachea.

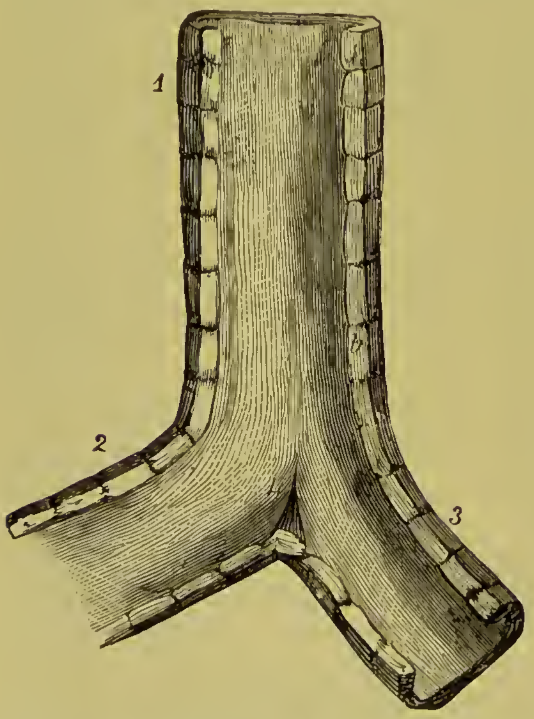

Fig. 650.—Bronchial septum; trachea and bronchial tubes laid open in front: 1, trachea; 2, right bronchial tube; 3, left bronchial tube; 4, bronchial septum, somewhat magnified to render it more conspicuous (Gross).

Substances lodged in the esophagus may ulcerate through into the trachea or pass into it through fistulous openings. Bronchial glands have also ulcerated through into the trachea and acted as foreign bodies.

The location and position of a foreign body depends much upon its size and shape. Sharp, penetrating objects are frequently found sticking in the supraglottic portion of the larynx. Large alimentary substances or angular bodies are usually found in the larynx. Flat bodies, such as coins and buttons, are usually found in the ventricles of the larynx; while small, round, and heavy bodies commonly descend into the trachea. Small bodies that enter the bronchi usually enter the right one, since the bronchial septum is on the left side of the median line, as first pointed out by Goodell of Dublin, as shown in Fig. 650. Of 98 cases collected by the writer, 58 were found to be in the right bronchus and 36 in the left. Of 156 cases, Bourdillet found that the foreign body was arrested in the larynx 35, in the trachea 80, in the right bronchus 28, and in the left bronchus 15 times.

Substances lodged in the trachea change their position more often than those in the larynx. Sometimes they play up and down, as in the case reported by Glasgow, where a toy balloon, which had entered the trachea, moved up and down with each inspiration. Physical changes also take place in the foreign body. Mineral substances usually become more or less corroded. Corks, beans, grains of corn, and other dry substances absorb moisture and swell sometimes to double their original size, and in some instances seeds have been known to germinate in the air-passages.

The **symptoms** of foreign bodies in the larynx vary from complete and instantaneous suffocation, as in the case of an impaction of a mass of meat, to an almost complete absence of manifestations, as in the case of small or smooth, non-irritating substances.

The usual symptoms attending the lodgement of foreign bodies in the larynx are those of sudden choking, cough, and efforts at dislodging the substances. When the breathing is materially interfered with the patient often becomes excited and alarmed, and makes frantic efforts to obtain air. He grasps his throat, his eyes protrude, and his face becomes livid from the lack of oxygenation of the air.

Frequently these symptoms are occasioned only by the spasm of the larynx excited by the presence of the foreign body, and soon subside. In cases, however, due to mechanical obstruction, these symptoms continue until death ensues.

Small, sharp bodies, such as fish-bones, pins, needles, and the like, which usually penetrate the upper portion of the larynx, excite more or less cough and cause much discomfort on swallowing.

Substances lodged in the larynx, but lying in such a position as not to obstruct respiration, are attended with more or less hoarseness and coughing, as in the case of coins, and in some instances tooth-plates. These cause active symptoms only after congestion or inflammation has taken place.

Smooth, round bodies cause little irritation; while sharp or angular bodies cause inflammatory symptoms.

Foreign bodies finding their way into the trachea are usually manifested by a cough, dyspnea, and efforts at expulsion. If the dyspnea is continuous, it indicates that the foreign body has become impacted in the trachea or a bronchus; if intermittent, that it is movable in the trachea; if there is collapse of one lung, that it occupies one of the bronchi; or if there is interlobular emphysema of the lung, that there is laceration of some portion of the air-passages. Pain is almost always present, and may clearly indicate the location of the foreign body.

Sometimes the presence of the foreign body is manifested by frequent hemorrhages, emaciation, and all of the symptoms of phthisis, which cease on the expulsion or removal of the foreign body.

When a foreign body has been retained for a length of time, there is usually more or less fetor of the breath from decomposition of the foreign body or of the retained secretions. Frequently disease of the bronchi or pulmonary structure intervenes, and sometimes pericardial, mediastinal, or hepatic abscesses have resulted from ulceration and the extension of the inflammation to the surrounding structures.

The **diagnosis** of the case is greatly facilitated by the history of the accident. When there is no history, as in a case where the foreign body has entered during a period of unconsciousness, as in an epileptic seizure or sleep, reliance must be placed upon the physical examination. A laryngoscopic examination can be usually made. In the case of a "Punch-and-Judy" whistle lodged in the lower part of the trachea of a boy eight years old, it was readily discovered by the author by the aid of the laryngoscopic mirror. When a laryngoscopic examination cannot be made the larynx can be explored with the finger; and when in the trachea, auscultation will frequently reveal the presence and location of the body—if a whistle, by a whistling sound, and if movable, by a "flapping noise" or Zwinger's "chattering bruit." When the air is excluded from one lung by reason of an obstruction of a bronchus, if it is in the right bronchus the lower lobe will be affected; while if in the left bronchus the entrance of air to the whole lung will be obstructed.

When the nature and location of the foreign body cannot readily be determined the X-rays should be employed, for they may not only locate the substance, but also materially assist in its extraction by showing its form and position.

Dyspnea caused by a foreign body lodged in a bronchus is sometimes mistaken for a foreign body in the trachea; and in a case where death was almost instantaneous from the blocking of the larynx, the death might be attributed to epilepsy or apoplexy.

The **prognosis** of foreign bodies in the trachea is always more or less serious. When death does not take place from suffocation serious inflammatory disturbance may arise, or there may be a sudden change of position of the foreign body, either in the larynx or trachea, which at any time may cause a fatal result. Small, smooth, non-irritating bodies rarely produce serious results, and are almost always expelled spontaneously; whereas sharp, angular or pointed bodies, even though suffocation be not imminent, should be removed as soon as possible.

The general consensus of opinion of surgeons is that no foreign bodies should be allowed to remain any length of time in the air-passages without the operation of bronchotomy. On the other hand, Weiss, from a collection of 1000 cases, mostly those reported to him privately, concludes that when the trachea and bronchus contain a foreign body, the patient will be more liable to recover if trusted to spontaneous expulsion. The statistics on this point are not of special value, for many patients die from suffocation who would have been saved by an operation, and many die after the operation when the foreign body might have been expelled spontaneously with recovery.

Substances entering the air-passages are usually expelled through the opening by which they entered, although in many instances, like bullets, heads of grain, etc., they have entered through the chest or the esophagus and have been expelled through the trachea. In other instances substances like heads of grain have entered through the larynx and trachea and were expelled through abscesses of the chest-wall.

Treatment.—The first and most important indication is the removal of the foreign body; but the method of removal will depend largely upon its nature and location.

Expulsion through the natural passages is facilitated by the use of a little chloroform to allay the excitability of the patient and the irritability of the parts occasioned by the presence of the foreign body. Among the natural aids are the various expulsive efforts, such as sneezing, coughing, vomiting; and by inversion, aided by percussion and circussion of the chest. The use of the sternutatories and emetics, tickling the nose with a feather to promote sneezing, and of the throat to produce vomiting, have been employed from the earliest times. But little reliance, however, can be placed upon these methods.

In the case of movable bodies, such as coins, bullets, and similar weighty substances, inversion of the body will sometimes cause the immediate expulsion of the substance. The danger with which some regard this method from the impaction of the substance in the larynx is largely imaginary, for no case is reported where death has resulted. Of several methods of inversion the best is that described by Padley of Swansea: The patient is directed to sit on the elevated end of a bench, with his knees flexed over the end. He then lies backward on the inclined plane thus formed, and the coin drops into the mouth. Danger of spasm or impaction in the larynx is avoided by the ability of the patient to at once assume the upright position. The patient should inspire deeply and avoid speaking. A blow or slap on the chest will sometimes aid in the expulsion of a coin.

In the case of animate bodies lodged in the larynx, such as leeches and the like, they are best dislodged by swallowing turpentine or chlorid of sodium.

In some cases the introduction of an O'Dwyer tube is temporarily necessary to prevent suffocation from impaction or spasm of the larynx.

Extraction through the Natural Passages.—This should be done with the guidance of the laryngeal mirror; when this is not possible the instrument can be guided with the index finger, as in the introduction of the O'Dwyer tube (see page 1030). When the foreign body occupies the supraglottic portion of the larynx, Cusco's lever blade-forceps or Mackenzie's angular forceps are the most serviceable; but when in the subglottic portion of the larynx or in the trachea, Seiler's or Mackenzie's (Fig. 651) tube-forceps are the best. Mackenzie's tube-forceps with the blade having a lateral grasp are especially ser-

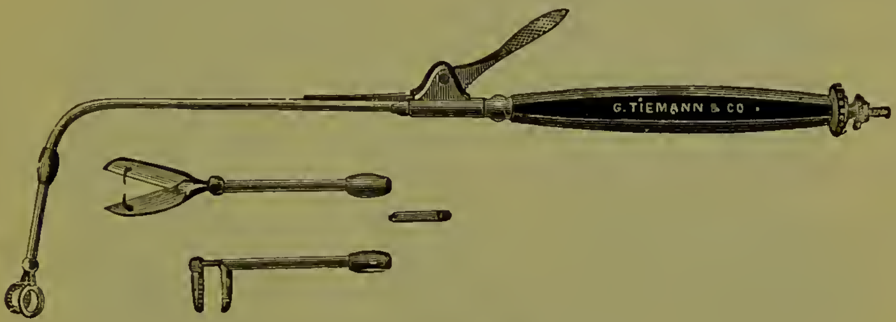

Fig. 651.—Mackenzie's tube-forceps.

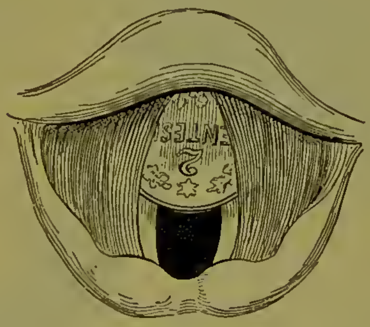

Fig. 652.—A coin in the laryngeal ventricle (Grazzi).

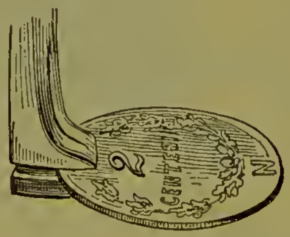

Fig. 653.—The same coin in the grasp of the instrument (Grazzi).

viceable for the removal of coins impacted in the larynx. Fig. 652 represents the well-known case in which Grazzi removed from the larynx a two centesimi piece in this manner. Some rough or angular bodies lie between the vocal cords. It is not advisable to remove them through the larynx if there is danger of lacerating the larynx sufficiently to impair the voice permanently. Sometimes the removal can be accomplished only after the swelling has subsided under appropriate treatment.

When the foreign body is so located or impacted that it cannot be expelled or extracted through the natural passages, artificial openings must be resorted to. The various operations that are frequently called for are governed by the location of the foreign body; if in the larynx, thyrotomy or crico-thyroid laryngotomy, or if in the lower part of the larynx, laryngo-tracheotomy or tracheotomy; if in the trachea or bronchi, low tracheotomy.

When the trachea is opened the foreign body may be expelled either through the larynx or the tracheal opening, or it may be thrown up into the upper part of the trachea so as to be readily grasped with a pair of forceps. If the substance is in the larynx, it can now be more readily extracted, or it may be forced out of the larynx from below with a sound; or a piece of silk may be passed down from the mouth and a piece of sponge drawn up through the larynx from below.

Expulsion from the trachea is aided by turning on the face, inversion, succussion, and blowing into the trachea, or tickling it with a feather to excite cough.

The tracheal wound should be held widely open with suitable retractors such as Laborde's (Fig. 654), Golding-Bird's (Fig. 655), or Minor's retractor.

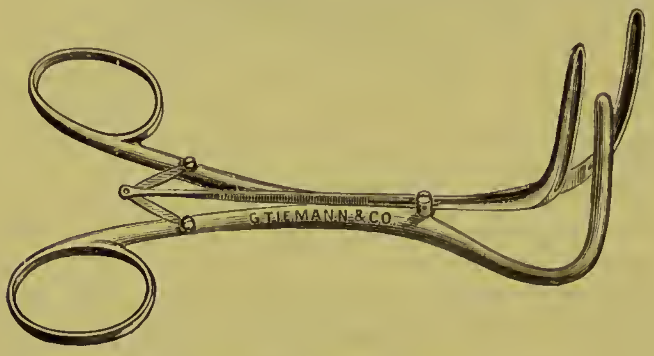

FIG. 654.—Laborde's dilator.

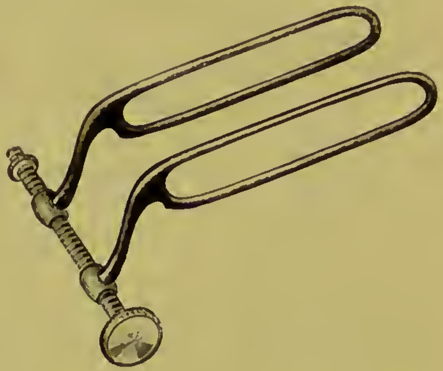

FIG. 655.—Golding-Bird's double retractor.

If the foreign body is not immediately expelled, Wythe's plan of stitching the edges of the tracheal wound to the integument is an excellent scheme to afford ready exit for the foreign body at any time. No tracheal cannula, of course, should be introduced. When the body is not expelled at once, it should be extracted by suitable instruments. Roe's tracheal forceps (Fig.

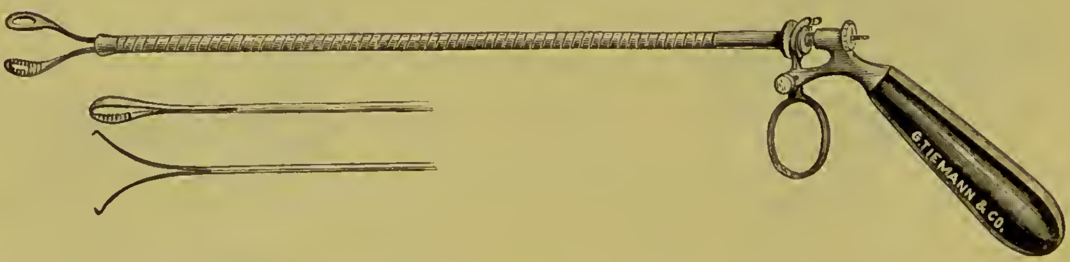

FIG. 656.—Roe's tracheal forceps, with flexible spiral tube.

656), the stem being made of copper, so that it can be bent into any required position for reaching into a bronchus, is especially suitable. Gross's and Cohen's tracheal forceps are also serviceable instruments. Sometimes the position of the body can be ascertained by reflecting light, or tracheoscopy, and removed or dislodged with a hook made of a silver probe by bending up the end, and extracting with the aid of the finger.

Attempts at extraction should not be sufficiently prolonged to cause irritation of the part or exhaustion of the patient. We should rather wait for loosening and expulsion to take place. When this loosening does not take place and removal of the body must be effected, the operation of bronchotomy through the chest-walls, as suggested by Quénu and Figueira, or the plan of reaching the bronchi through an opening in the chest-wall from behind, by incising the third to sixth dorsal vertebræ, as proposed by Nesiloff, is to be considered.

Foreign Bodies in the Pharynx and Esophagus.—Foreign substances of almost every variety have been found in the pharynx and esophagus. They may enter through the mouth or through the neck, as in the case of gunshot wounds, or the substance may be thrown up from the stomach and impacted in the esophagus.

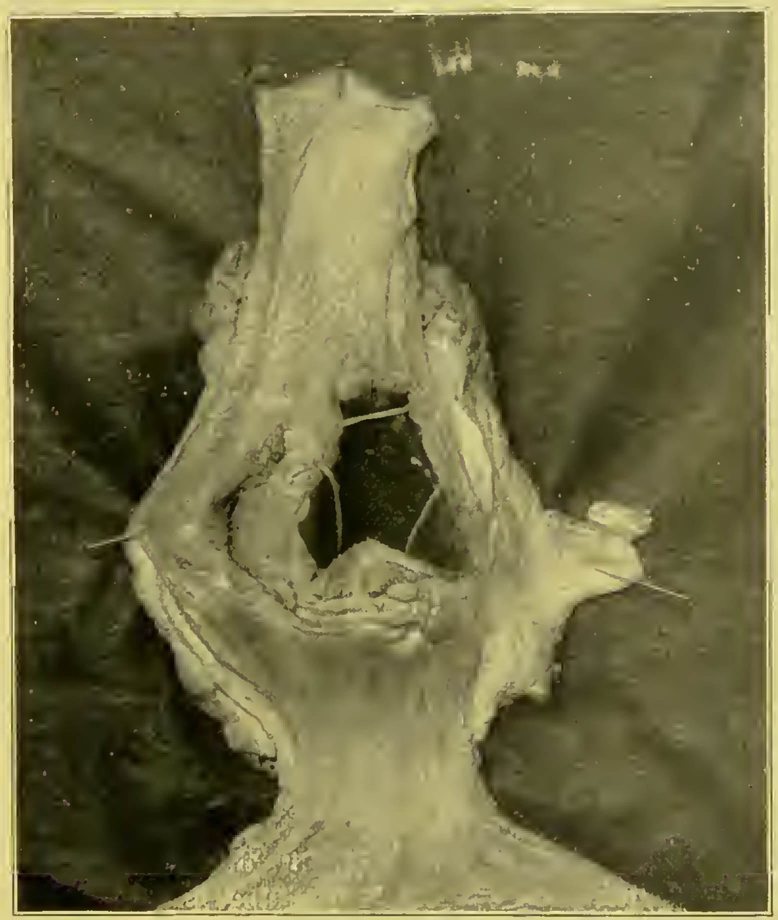

FIG. 657.—Tooth-plate lodged in a diverticulum in the esophagus for nearly two years. The patient insisted that the plate was in her esophagus, but exploration failed to detect it during life (Silver).

Foreign bodies in the esophagus are usually arrested in the middle third where it is crossed by the left bronchus, or at the cardiac extremity, which is the narrowest portion of the tube.

Many pathological conditions favor the lodgement of foreign bodies in the pharynx and esophagus, such as inflammatory affections, diseased conditions of the tongue, tonsils, pharynx, larynx, and esophagus, which interfere with deglutition and induce the sudden bolting of food in large quantities.

Substances carelessly placed in the mouth frequently become lodged in the throat, and during sleep tooth-plates and other substances often drop into the throat and become impacted in the esophagus; in some instances this takes place without the knowledge of the patient.

The **symptoms** attending the lodgement of foreign bodies in the pharynx and esophagus are usually dyspnea, laryngeal spasm, dysphagia, and pain in the region of the impaction.

Sometimes the dyspnea from the pressure of the foreign substance on the trachea is so great that it simulates the lodgement of a foreign body in the trachea or larynx. In nervous and excitable people the lodgement of such bodies in the throat or esophagus is sometimes purely imaginary, although all the symptoms of their presence are produced. In other instances foreign bodies have remained in the esophagus for years, entirely unsuspected, the disturbance caused by them being attributed to other causes. A pouch or diverticulum on one side of the esophagus will sometimes form for their lodgement, leaving the passage free, and sometimes they become encysted. Fig. 657 represents a tooth-plate lodged in a diverticulum in the esophagus for nearly two years. Its presence was suspected, but it could not be detected during life.

Sharp and slender substances, such as pins, needles, heads of grain, may pass through the walls of the esophagus, migrate to other parts, and emerge through an abscess. Foreign bodies, however, that remain for any length of time frequently produce the death of the patient or alarming conditions, such as edema of the larynx, abscesses, ulceration and stricture of the esophagus, perforation or rupture of the walls of the esophagus, penetration of the pericardium, the heart, the pleural cavity, larynx, and trachea, or caries of the vertebræ.

Diagnosis.—Foreign bodies lodged in the pharynx and upper part of the esophagus may be detected by inspection of the neck, if the substance is sufficiently large to give it a bulging appearance, by laryngoscopic examination, by palpation with the finger, and by exploration with sounds or by the *X*-rays.

In the lower part of the esophagus the foreign body can be detected with the sound and by auscultation of the esophagus over the back during deglutition, where a peculiar gurgling sound is heard at the location of the foreign body.

The esophagus can also be inspected by means of Mackenzie's esophagoscope, or it can be electrically illuminated by Mikulicz's esophagoscope. Duplay's resonator is especially serviceable for the detection of metallic substances. The sound, having a metallic tube, is attached to the hollow metallic cylinder, from which the sound is conducted to the ear. The striking of the metallic end of the bougie against the metallic substance is so magnified that the slightest touch can be detected.

Treatment.—Foreign bodies are removed from the pharynx and esophagus, first, through expulsion by natural means, as coughing, vomiting, and artificial digestion; second, by extraction by means of forceps, hooks, rings, and dilating probangs; third, by propulsion with the sponge-probang or by crushing the substance so that it will pass forward; fourth, by incision—by pharyngotomy or esophagotomy.

The employment of emetics is not only ill-advised but sometimes dangerous, owing to the liability of rupturing the esophagus or of lacerating it during expulsion in case of sharp angular bodies. When small bodies are impacted it has been proposed that milk be ingested, and as soon as it has had time to form a firm curd be ejected by the action of a prompt emetic, so

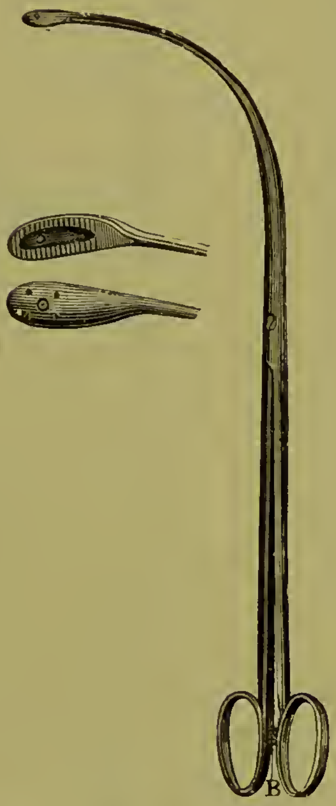

Fig. 658.—Fauvel's forceps, lateral grasp.

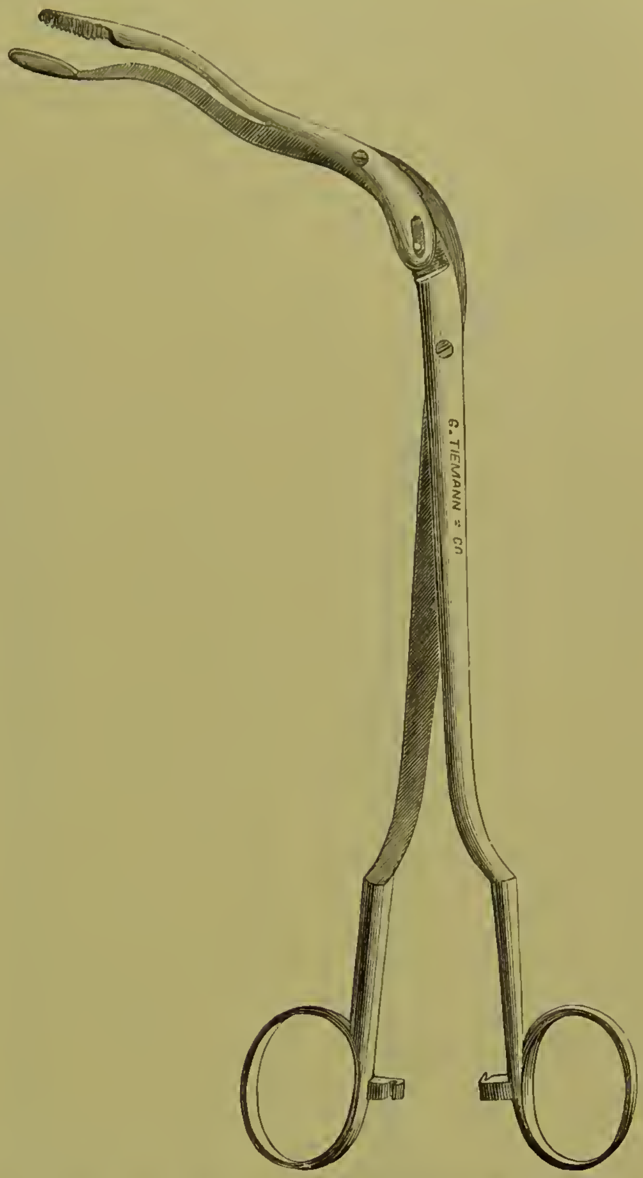

Fig. 659.—Fauvel's forceps, antero-posterior grasp.

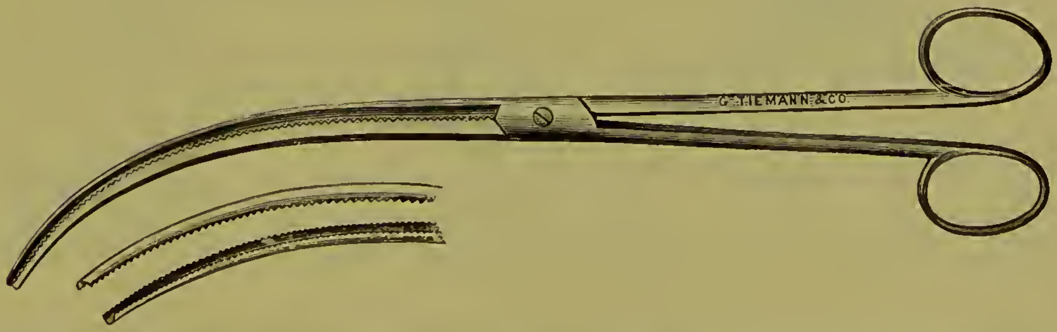

Fig. 660.—Bond's forceps (modified by author), with blades bevelled inward to avoid grasping mucous membrane, and to permit slender bodies readily to turn lengthwise.

that it may sweep away the intruder. On the other hand, soft, bulky food, like oatmeal, may be swallowed in the endeavor to sweep on the foreign substance, and such food should always be freely given after tooth-plates and such bodies have entered the stomach.

For the removal of substances from the pharynx and upper part of the esophagus Fauvel's forceps (Fig. 658) and Bond's forceps (Fig. 660), as modified by the author, having a very narrow biting surface, are especially serviceable instruments. Moe's flexible-stem forceps (Fig. 661) are especially adapted for removing substances from the lower part of the esophagus.

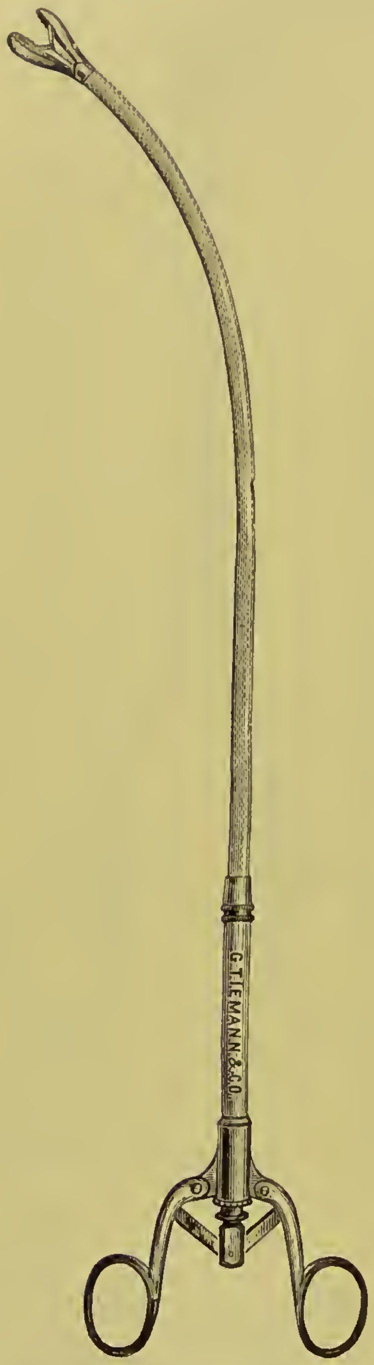

FIG. 661.—Moe's gum-elastic forceps, with a tube so soft that it can follow the curves of the bronchi or esophagus.

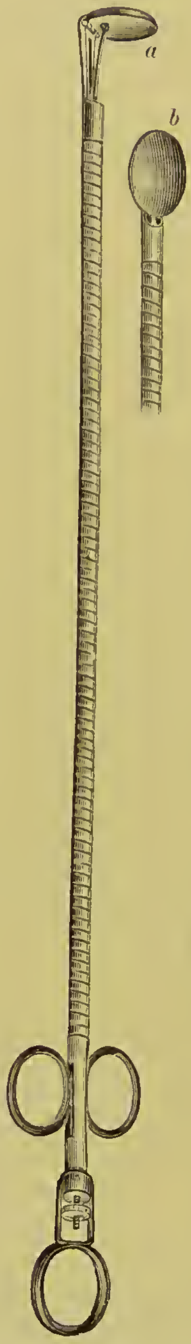

FIG. 662.—Roe's flexible spiral-lever extractor: *a*, lever opened after having been passed beyond the foreign body; *b*, closed during introduction or after the foreign body is grasped.

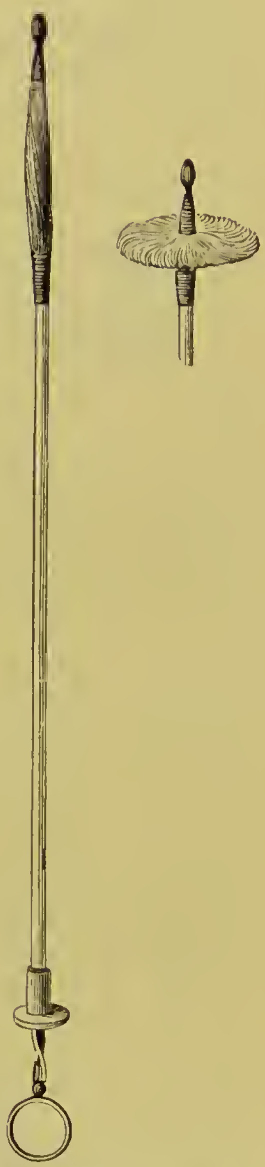

FIG. 663.—Gross's bristle probang, closed to pass the foreign body, and opened so as gently to sweep it upward in its withdrawal.

Roe's flexible spiral-lever extractor (Fig. 662) and Graefe's ring coincatcher are most useful for removing coins, metallic disks, and similar substances.

Gross's bristle umbrella probang (Fig. 663), inserted beyond the foreign body while closed and then expanded before withdrawal, is an excellent instrument for general use, and is adapted for the extraction of a variety of small substances, such as fish-bones, pins, and the like.

A great many different devices are often required for the removal of different substances, as Baud and Leroy devised passing drilled lead-balls over the string to dislodge fish-hooks and to protect the esophagus from the sharp ends during extraction.

In numerous instances similar ingenious devices have been resorted to for the extraction of different substances. In every case, however, great care should be taken not to irritate or lacerate or bruise the esophagus with the bite of the forceps or by the employment of too much force in extraction, lest serious inflammation be excited.

When a foreign body has become so firmly impacted in the pharynx or the upper part of the esophagus that it cannot be extracted *per vias naturales*, the operation of pharyngotomy or esophagotomy should be resorted to without delay. The rule laid down by Fisher is a safe one to follow—viz., in every case in which the foreign body cannot be removed within twenty-four hours after it has been impacted in the esophagus, external operations should be performed to obviate the danger of fatal internal complication.

Injuries and deformities of the pharynx and lower air-passages are not of frequent occurrence in forms that need special consideration here. Wounds, whether of cut-throat or other character, rather fall in the province of the general surgeon, except as inflicted by foreign bodies or laryngological surgery, when they concern the laryngologist largely as causes of severe and dangerous inflammation or edema. The latter condition sometimes ends fatally in the cachectic after the most trivial injuries, as in v. Ziemssen's case of a consumptive dying almost instantly after a prick of his ventricular band by a bit of inhaled tobacco-leaf. Scalds or other burns of the throat, most commonly from the swallowing of caustic substances, may also require a prompt opening of the air-passages in order to prevent suffocation, and prolonged antiphlogistic treatment to allay the inflammation excited, with ultimate operation to relieve the resulting stenosis.

Fracture of the larynx, generally of the exposed rostrum of the thyroid, as in cases reported by the author,[1] is occasionally seen, with not infrequently fatal result; while a cornu of the thyroid has at times been fractured by a blow or throttling pressure and dislocated inward, to be conspicuous in the supraglottic larynx-cavity.

Stenosis of the larynx from pachydermia, trauma, or syphilitic cicatrization may demand dilatation with the laryngeal catheter or such instruments as the author's forceps (see page 1209).

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[1] *Ann. of Laryngol.*, April, 1881.

NEUROSES OF THE UPPER AIR-PASSAGES.

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SENSORY NEUROSES OF THE NOSE.

Disturbances of Olfaction.

Anosmia.—Absolute loss of smell from any cause is of rare occurrence. Great variation exists, both in normal and abnormal conditions of the nasal mucous membrane, in the intensity of olfactory impressions. Depending, as we must, almost exclusively upon the statements of the patients, their neurotic vagaries must always be taken into account in considering the etiology. Zwaardemaker and Schmidt[1] have divided the cases into the *respiratory* and the *essential*. By the *respiratory* we are to understand any condition which prevents the access of odor-laden air to the mucous membrane of the olfactory region. Such are, especially, nasal polypi, dryness of the mucous membrane and the formation of crusts upon it. Essential anosmia is due to actual lesions of the olfactory tract. There may be a chronic atrophic rhinitis or an acute inflammation of the olfactory mucous membrane, as in the case reported by Vergniaud.[2] The filaments given off from the olfactory bulb may be torn through by the jar of blows or falls on the occiput, as reported in several cases by Ogle, on whose paper,[3] in 1870, most of the literature is founded. There may be an actual olfactory neuritis, as in a case mentioned by Althaus.[4] Darwin, in his famous *Origin of Species*, drew attention to the fact that white sheep and pigs are poisoned by certain plants, while dark-colored ones are not. Ogle enlarges upon this fact, and quotes the case related by Hutchinson[5] of the negro who, on changing color by losing his dark pigment and becoming an albino, also lost his sense of smell. Ogle shows that it is highly probable that these phenomena depend upon the absence or loss of pigment in the olfactory mucous membrane. He states that the dark-skinned animals are enabled by their keen sense of smell to avoid the noxious plants; while the white animals, with pale Schneiderian membranes and feeble sense of smell, eat and are poisoned by them (see page 839). It is a fact easily observed that dogs, whose sense of smell is acute, have a deeply pigmented nasal mucosa. Syphilis of any part of the olfactory tract is said by Dana[6] to be the most frequent cause of essential anosmia. The last-named author also mentions several cases due to lesions of the olfactory bulbs and the cortical centers in the gyrus hippocampi and uncinatus. Cases are referred to by Mackenzie[7] in which

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[1] *Die Krankheiten der Oberen Luftwege.*

[2] *Revue de Laryngologie*, etc., No. 17, Sept. 1, 1894.

[3] *Medico-Chirurg. Trans.*, 1870, liii. p. 263.

[4] *Lancet*, May 14 and 21, 1881.

[5] *Amer. Journ. of the Med. Sciences*, 1852, vol. xxiii. p. 146.

[6] *N. Y. Med. Journ.*, Sept. 7, 1889.

[7] *Diseases of the Throat and Nose*, 1884.

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there was congenital absence of the olfactory nerves and bulbs. Locomotor ataxia and cortical cerebral tumors and abscesses have been shown to be the causes of anosmia in some cases. In cases of paralysis it has generally been noted that the anosmia is unilateral and on the side of the lesion, there being no decussation of the olfactory tracts. We find various cases of anosmia reported as depending upon tobacco-poisoning (Parker), malaria (Raynaud)—when the anosmia was intermittent and cured by quinin—lead-poisoning (Grant), irritant substances, such as ether and snuff (Stricker), and astringent solution, such as alum (Wendt). Exceedingly foul smells (Althaus) or the prolonged smelling of any perfume, as in the case of the flour-tester mentioned by Wagner, may blunt the sense of smell, or the appreciation only of the accustomed odor. Anosmia may arise from reflex causes, such as elongation of the uvula (Lennox-Browne, Mackenzie), removal of the ovaries (Gottschalk), cauterization of the inferior turbinal bodies (Luc). Some doubtful cases are on record, ascribed to gout and rheumatism (Durrant, Mackenzie). In old age there may be a senile abatement of the acuteness or an entire loss of smell.

Notwithstanding this long array of causes, there is still another and perhaps a larger set of cases in which the most painstaking search fails to account for the anosmia. There are also many patients, who say they can smell nothing, in whom evidently the olfactory sense is unaffected or only slightly impaired.

Anosmia is frequently accompanied by loss of taste, but not always. Macdonald supposes that the posterior part of the olfactory tract is the region which governs the sense of taste. The essential qualities of taste, such as bitter and sweet, may be retained in anosmia, but the more delicate aroma of food is not appreciated. This is supposed to ascend through the nasopharynx to the olfactory region above the middle turbinated bone. Zwaardemaker has found that cocain powder mixed with starch and blown into the olfactory region will produce temporary anosmia. The latter author, in 1888, devised an instrument for measuring the olfactive powers of the nose, and called it an olfactometer (see Fig. 554). More recently[1] he has published a description of an improved, but more complicated, apparatus for the purpose. He recommends the use of valerianic acid in a solution 1 : 100,000, and various other unusual substances, among which he prefers vanillin 1 : 1000. For ordinary purposes the various essential oils, ether, vinegar, wood-alcohol, etc., in bottles, may be used to ascertain the olfactive condition of the patient.

The **prognosis** depends to a large extent upon the lesion, yet Mackenzie makes the statement that after anosmia has existed for two years we should hold out to the patient little hope of the restoration of the sense of smell. The principal exceptions to this rule are found in the respiratory cases of anosmia. Thus d'Aguanno restored the sense of smell in a case of anosmia from nasal polypi which had existed forty years; and White,[2] in two cases, one after twenty years and one after ten years, accomplished a cure. Occasionally the essential cases will recover; but, as a rule, it will be found that no treatment is efficacious, even the removal of the primary cause, because structural change has taken place in the olfactory tract itself.

Treatment.—Removal of the cause in the respiratory cases, the administration of quinin and strychnin in the neurotic, the discovery and correction of the cause in the reflex cases, are the indications for treatment. Some cases have recovered after the application of galvanism; and Mackenzie claims to have given relief in two cases by the insufflation of

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[1] *Archiv f. Laryngologie*, Bd. iii., Heft ii., 1895.

[2] Burnett's *System of the Diseases of Ear, Nose, and Throat*, vol. ii. p. 94.

℞. Strychnin, gr. $\frac{1}{24}$—$\frac{1}{12}$;
Starch, gr. ij —M.

Hyperosmia seems common enough among highly neurotic women and men, but their complaints of certain odors would seem to be due more to their mental attitude and lack of self-control than to a really hyperesthetic state of the olfactory tract. It is occasionally noted in women at the time of menstruation. It differs from parosmia in being an exaggerated appreciation of one or more odors rather than a perversion of them.

Schmidt refers to some cases of morbid hyperosmia; while Schech[1] speaks of a boy (James Mitchell) who, in the absence of his other senses, was able to recognize objects or individuals by their odor. The same is also related of Laura Bridgman.

Parosmia, or the perversion of smell, is said to be always either of cerebral or hysterical origin. It is, however, not uncommonly a more or less marked symptom of a bad coryza. This was especially noted during the late epidemic of the grippe. The odor of putrid flesh, fish, eggs, the smell of cooking meat, urine, petroleum, musk, burning hair, tar, pitch, phosphorus, garlic, or other indescribable and disgusting odors, are complained of. It is rather singular that in none of these cases has there been noted the occurrence of agreeable olfactory sensations. Mackenzie refers to cases in which the symptom was due to carcinoma of the frontal lobe of the brain, a glioma, gummata, or a fungous tumor of the cribriform plate. Althaus[2] relates a case in which parosmia was the beginning symptom of locomotor ataxia. There are many instances of it found among the insane, and it is occasionally reported in the aura of epilepsy. It is especially frequent in neurasthenia; and in women during pregnancy and at the menopause. A curious report by Sbreny states that, in a patient of his, cocainization of the nasal mucous membrane repeatedly produced the sensation of a foul smell.

Prognosis.—In cases of cerebral origin the prognosis is bad, unless arising from a syphilitic lesion, where treatment may be of avail. In the insane and hysterical it depends on the general prognosis in the case. When dependent on local causes, as coryza, the prognosis is good.

Treatment depends on the etiology. Parosmia is a symptom.

The sense of smell has a more or less direct connection with the emotional life of man. Its connection with sexual excitement is a common phenomenon in animals. In the human race young women make use of artificial scents not only for their own gratification, but also to enhance their attractions for the other sex. Man being by nature the aggressive party, is less addicted to their use.

Goethe tells of Schiller keeping rotting apples in his writing desk, because in their atmosphere his poetic conceptions flowed more freely from his pen. In some individuals certain odors, or even the thought of them, produce headache, dizziness, faintness, or give rise to certain conditions. On the other hand, psychical influences may give rise to the subjective perception of odors.

"And I swear, as I thought of her there, in that hour,
And of how, after all, old things are best,
That I smelt the smell of that jasmine flower
Which she used to wear in her breast.

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[1] *Krankheiten der Mundhöhle*, etc., f. 279.

[2] *Loc. cit.*

It smelt so faint, and it smelt so sweet,
  It made me creep, and it made me cold;
Like the scent that steals from the crumbling sheet,
  When a mummy is half unrolled."

Disturbances of Sensation.

Anesthesia; Hyperesthesia; Paresthesia.—It is to be remembered that a small part of the anterior portion of the nasal chambers receives its sensory nerve-supply from the nasal branch of the ophthalmic division of the fifth or trigeminus nerve, and that the rest of the nose is supplied by the superior maxillary division, and the tongue and mouth by the inferior, with its gustatory branch; and that these three divisions unite at the Gasserian ganglion within the cranial cavity. It is probable that in many cases of cerebral hemorrhage, especially those in which there is facial anesthesia, the nasal mucous membrane, if examined, would be found anesthetic. The case mentioned by Althaus is the only one on record, so far as I know, where there was a peripheral paralysis of the fifth nerve. There were trophic changes in the mucous membrane of the eye, nose, and mouth; but the senses of smell and taste remained intact.

Hyperesthesia and hyperalgesia are so intimately connected with local lesions and reflex neuroses that they will be considered elsewhere.

Paresthesiæ of the nose may be the occasional symptoms of cerebral and nerve lesions; but hysteria here plays the most important part in the etiology. While it is not my plan to dwell long upon hysteria, I cannot refrain from giving the following account of a remarkable case which many American laryngologists will doubtless remember, as she has consulted a very large number of them.

The patient was a nervous woman of fifty, with a good family history. Fifteen years before she had received a blow with a parasol on the bridge of the nose: seven years ago she began to complain of nasal obstruction. Six years ago the menopause began. She has the appearance of a healthy woman, but she says that she suffers agony from frontal headache, pain within the nose, and nasal obstruction. Several years ago a surgeon removed a large piece from the nasal septum. From time to time since then several doctors, at her entreaty, have removed pieces. One rhinologist opened the frontal sinus and found it healthy. All these operations had given her only transient relief. She had other neurotic symptoms, upon which, however, she did not dwell. While giving me her history she drew from her pocket a bent-wire probe wound with cotton, and passing it dexterously into her nose, said she could feel that there was still something there, which she begged me to cut out. On inspection I found that the whole septum from the columna to the naso-pharynx had been removed, with the exception of a small ridge or blade of tissue along the floor of the nose. The middle turbinals met in the middle line, so that if there was any septum above them it could not be perceived. She assured me that this had been removed piecemeal by different doctors, and placing her probe upon the remaining stump, and moving it back and forth, she told me that if I did not take away that she would go to some one who would. I refused, and advised her to seek an alienist. She left my office in anger.

This may be said to be a case of "obsession" rather than of hysteria.

REFLEX NEUROSES OF THE NOSE.

I do not propose to enter into a discussion of the nature of a reflex neurosis further than to say that we commonly understand by it a process which consists of a nervous impulse starting at the peripheral termination of a sensitive nerve, carried through it to a sympathetic center, and from there carried back to its source or to a distant point, where it manifests itself in an excessive or disordered vaso-motor, sensory, or muscular activity. To account for this disordered activity, we may suppose that the terminal nerve-filaments are diseased or subject to undue irritation by disease of their environment; or that there is disease of the nerve-trunks or their ganglia; or that there is a general excitability of the nervous organization of the individual. Pathology has as yet shed no new light on these possible sources of the trouble; and the clinical phenomena are so illusive that they have furnished only a multitude of bewildering hypotheses and theories. Since the rise of specialism in medicine, the devotee of each shrine has laid at the feet of his deity—the nose, the uterus, the stomach, the male urethra, or other isolated organs—as large a number of reflex neuroses as possible. It has therefore repeatedly happened that the same nervous phenomenon appears in many classifications; and the result has been bewildering and, to the candid observer, somewhat ridiculous.

Hay-fever, of late years, has been most frequently considered as belonging etiologically to the nose. Cases of epilepsy, melancholia, insomnia, neurasthenia, migraine, persistent hiccough, aprosexia, sneezing, and many other puzzling affections have appeared to some of the reporters to originate in the nose, chiefly because they have observed some case coincident with nasal disease and abolished by treatment of it. But the same galaxy of phenomena has also been ascribed with equal right to other organs. Therefore logic teaches us that we are familiar only with the everchanging factor, and not with the central or constant one which we presume must exist.

Hay-Fever.—John N. Mackenzie,[1] in a historical study of the nasal reflexes, has shown that hay-fever and other nasal neuroses had been observed clinically from the earliest ages, but not classified in accordance with present knowledge and theories. At the beginning of this century, Heberden and Cullen had evidently observed the affection; but Bostock,[2] in 1819, was the first to describe it intelligently. Phoebus, Weyman, Beard, Blackley, Geddings, and others have made valuable contributions to the subject since then; but they devoted themselves to its clinical manifestations and its etiological dependence on extraneous influences rather than upon local nasal disease. Daly, in 1881, was the first to draw attention to the fact that a very large number of these patients had well-marked intranasal lesions. In this he was supported in this country by Roe,[3] Harrison Allen,[4] Sajous,[5] and abroad by Hack, Hertzog, and others. These gentlemen were disposed to look upon the general neurotic element as a minor factor or as a result of the local lesion. John N. Mackenzie,[6] in a remarkable series of articles, while giving local lesions their due consideration, has shown that the fundamental cause lies back of these in the abnormal excitability of the sympathetic nervous system. Bishop[7] has lately advanced the theory, with considerable force of argument, that hay-fever is due to the hyperacidity of the blood from the excess of uric acid; but it is too early yet to judge of the value of this suggestion.

Hay-fever is a term usually limited to manifestations of disturbance in the upper air-passages, which begin in May or June, and are then sometimes called "Rose-cold" or "June cold;" or it may begin shortly after the 1st of August and last until the advent of frost. The latter form is the one more commonly known as hay-fever, hay-asthma, rag-weed fever, autumnal catarrh, etc.

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[1] *Trans. Am. Laryng. Assoc.*, 1887.

[2] *Medico-Chirurg. Trans.*, 1819, p. 161; 1828, p. 437.

[3] *N. Y. Med. Journ.*, May 12, 19, 1883; May 3, 10, 1884; *Trans. Am. Laryng. Assoc.*, 1884.

[4] *Am. Journ. Med. Sci.*, Jan., 1884.

[5] *Trans. Am. Laryng. Assoc.*, 1884.

[6] *Am. Journ. Med. Sci.*, April, 1884.

[7] *The Medical News*, Feb. 24, 1894.

Symptoms.—Its chief characteristics are those of a severe coryza in the early stages, which, instead of terminating in the third or resolving stage after ten days or two weeks, is indefinitely prolonged; or it may suddenly cease on an abrupt fall of temperature or the removal of the patient to another locality. Itching of the eyes and nose, alternating nasal obstruction, furious and long-continued fits of sneezing, lachrymation, photophobia, congestion of the conjunctivæ, frontal headache, more or less complete loss of taste and smell, an annoying cough, prostration and slight fever make these patients exceedingly uncomfortable, and for a considerable period render them unfit for any continuous occupation. Damp weather, east wind, dust, and the proximity of blooming vegetation increase the intensity of the symptoms. All degrees of severity are observed, from a very slight "cold in the head" to an illness which, for a part of the time, at least, may confine them to bed. The first of the periodical attacks is slight, and the severity increases with the recurring ones. The patients suffer much more in the morning hours than in the afternoon.

Etiology.—In this country the bloom of the rag-weed—ambrosia artemisiæfolia—is more often regarded by patients as the exciting cause of their attacks than any other plant; but the bloom of the cereals, dust, bright sunshine, and many other influences are used to explain the onset of the disease. The June cold or rose-cold, which presents the same clinical picture, but is certainly less frequent in this country than the autumnal form, has been supposed to be due to the pollen of the early flowers. It is probable that all floating particles of matter in the respired air have their effect upon the nasal mucous membranes of susceptible individuals. It occurs more frequently in the so-called temperate climates, being unusual in very warm or very cold regions. It is a very much more frequent occurrence in America and England than in other countries. Geddings, combining his cases with those of Weyman, says that it is more common in men than in women, in the proportion of 3 to 2. He gives the following table as to the age when the patients were first attacked:

Under 10	21 cases.
10–20	28 "
20–30	38 "
30–40	19 "
40–50	16 "
After 50	3 "

In many cases heredity seems to play an important part, many members of the same family suffering from it. This is especially so in certain families of a neurotic type or distinguished by intellectual superiority.

The attack frequently comes on with great regularity as to the time of year. Sometimes the patient confidently expects it not only upon a certain day, but even at a certain time of day, although occasionally the attacks occur at any time of the year. Bosworth quotes Beard's statistics and his own, from which it appears that out of 278 cases beginning from May 1 to September 30, 186 cases began between August 10 and 31 inclusive, while the other cases were pretty evenly divided as to the date of beginning. The attacks in some of the cases run a shorter course, but the majority suffer until frost, and some seem never to be entirely free from the trouble. In Geddings's tables there is a marked preponderance among brainworkers—physicians, manufacturers, merchants, clergymen, and lawyers making up much more than half of the cases. It occurs much more frequently among neurotic people, although Roe denies this. A good many of Geddings's cases are called "bilious." Most writers agree that the exciting extraneous cause seems most frequently to be the pollen of plants, since much the larger number of cases suffer only when the flowering plants shed their pollen, or in August and September, when the later grasses are in bloom. The experiments of Blackley and others point to the same conclusion; but it is also certain that other irritants in the respired air may act in the same way, since many of the cases suffer at irregular intervals throughout the year.

Notwithstanding many differences of opinion as to the relative importance of the factors in the etiology, those who have given the disease the most careful study agree that we must usually take into account:

1. Hyperexcitability of the sympathetic nervous system, which may or may not manifest itself by what we term a neurotic temperament.

2. Some local change in the nasal mucous membrane or its underlying cartilaginous and bony framework. This is most frequently found to consist of a real hyperplasia or a vascular dilatation of the erectile tissue or of an edematous (so-called polypoid) condition of the stroma, especially in the region of the middle turbinal. Combined with this, as pointed out by J. N. Mackenzie, we are able to find more or less localized areas of hyperesthesia in the posterior part of the nose. Spurs and deviations are more rarely a prominent local feature.

3. Some atmospheric condition (pollen, dust) which obtains principally either in the spring or the autumn.

Now, as a matter of fact, we not infrequently find cases in whom the neurosis of hay-fever is the only evidence of a neurotic temperament (Roe). We also often meet with cases that have no appreciable nasal lesion when not suffering from hay-fever (Mackenzie). Finally, as said above, many cases have the same manifestations at other seasons of the year or in localities where there is presumably neither dust nor pollen. The writer cannot escape the conviction that, in very many instances, but of course not in all, the local disease is the result, rather than the cause, of the neurosis. Excessive and long-continued vaso-motor disturbances lead to the demonstrable permanent damage of the fibro-muscular walls of the vessels and of the stroma of the erectile tissue of the nose. Low-grade inflammatory fibrous tissue takes the place of the elastic fibers of the normal stroma. It also encroaches upon, displaces, causes absorption of, and hinders the functional action of the smooth muscular tissue in the stroma and the walls of blood-vessels. Not only does it do this, but, as a consequence, the serous fluid thrown out from the vessels is finally, after repeated attacks, not absorbed, but remains as a permanent edematous infiltration of the stroma; and the cavernous spaces remain permanently dilated, owing to paresis of their walls, even after the vaso-motor storm has for the time passed away. This I have lately been able to observe in a young man who, after having had hay-fever for ten years to some extent, began to suffer more severely; and after the hay-fever season had passed this year, his nose remained more or less occluded. The mucous membrane of the whole nose was pale and edematous, in addition to the engorgement of the cavernous tissue, and reacted sluggishly to cocain. By means of the snare, pieces were removed both from the inferior turbinal and from the region of the middle turbinal. Small polyp-buds, some as large as a pea, some as small as a pin's head, were seen in process of budding or protruding from the surface. Microscopically there was a difference in the specimens of tissue from the two regions. There were a large number of glands in the tissue from the inferior turbinals, which, except for their distension with serum, did not look materially altered from the normal; but the stroma-fibers were evidently changing in character, and the smooth muscle-fibers, easily made out in the erectile regions when normal, were few and hard to find. In the middle turbinal region the structure was that usually found in the ordinary edematous polypus,[1] except that possibly the glands were not so much degenerated as usual. This and many other histological examinations simply tend to confirm the impression I have long received from cases clinically observed.

Prognosis.—Notwithstanding this, it is undeniably true that treatment directed to the local lesion, when it exists, results always in marked amelioration of the symptoms, and sometimes in a permanent cure. The cases with extensive nasal disease are the most favorable ones, for often when operated on they have apparently reached a stage when the neurosis is on a decline. Relieved of the peripheral irritation, perhaps originally brought about by the neurosis, nature so far overcomes the other etiological factors that the symptoms do not return at their next period. If the system becomes still further strengthened they may never recur; but after a few years many of these cases relapse. Another curious fact about these cases is that a shock to the nervous system, unconnected in any way with the treatment, may give temporary or lasting relief; as in the case mentioned by Dr. F. I. Knight, where a man, long a sufferer, broke his leg and the attacks ceased. He had also seen a case relieved by the mind cure. The case of Dr. J. N. Mackenzie has become famous, where an artificial rose produced a "rose-cold" in a sufferer from the affection, who, when disabused, was subsequently able to inhale the perfume of a real one.

Treatment.—From what has preceded, the indications for treatment seem pretty clear, although sometimes difficult to follow out. A careful inspection of the air-passages must be made, if possible, when the trouble is quiescent. All polypi, hypertrophies, spurs, and deviations in the nose must receive appropriate treatment, and all sensitive spots should be destroyed by the galvano-cautery. This should be done only by an experienced operator, and not by the tyro in rhinology, or innocent structure may be destroyed and annoying cicatrices and adhesions be left behind.

As for drugs, tonics of strychnin, quinin, and iron are indicated, and may be administered for weeks or months before the usual onset of the symptoms. Dr. Mackenzie's prescription is a pill—

℞. Zinci phosphid.,	gr. $\frac{1}{16}$;
Quin. sulph.,	gr. ij;
Ext. nucis vom.,	gr. $\frac{1}{4}$, before meals, and
Donovan's solution,	gtt. iij–v, after meals.

These patients must lead an out-door life, as free from mental strain as possible. Should all of these measures be found inefficacious, as often happens, there is nothing left for the patient but to seek refuge in stoic philosophy, or in distant localities, where experience teaches him that he is free from his trouble. This may be in the White Mountains of New Hampshire. "Of the various places mentioned within this territory, Bethlehem and Jefferson, Whitefield, White Mountain House, Fabian's Twin-Mountain House, Crawford House, Glen, Gorham, and Mount Washington may be regarded as entirely exempt" (Geddings).

Frequently immediate and entire relief is here experienced, and there is always great amelioration of the neurotic phenomena. The lake region of Maine, Lake Chautauqua in Western New York, Put-in-Bay on Lake Erie, Little Traverse Bay in Northern Michigan, Cresson in Pennsylvania, many parts of Canada, of California, and of Colorado are free from the disease, and give relief in many cases of hay-fever. Indeed, the seashore, the mountains—any change of locality—will relieve some patients; while nearly all are free from it during an ocean voyage.

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[1] Wright, *N. Y. Med. Journ.*, Nov. 4, 1893. See p. 1076 in this work.

Spasmodic Asthma.—Very shortly after the influence of the local nasal lesion was recognized and exaggerated in the etiology of hay-fever, interest was revived in a like causation of spasmodic asthma. To Voltolini is generally accredited the distinction of having in 1871 first drawn attention to the dependence of some cases of asthma upon nasal lesions, having cured a case by removing a polypus from the nose. This attracted a great deal of attention, and many papers were contributed to medical literature in confirmation of his observations; but the importance of nasal and pharyngeal disease as an etiological factor reached its climax in 1886, when Bosworth stated that in all the cases of asthma which he had seen there existed an intranasal lesion. In his book published in 1889 he repeated the statement. Out of 46 cases of asthma, 28 were cured and 12 improved by intranasal treatment, while only one was unimproved. He asserts that hay-fever or hay-asthma and perennial or bronchial asthma have the same etiology—*i. e.*, that the local exciting cause is always in the nose. He therefore calls the first vaso-motor rhinitis and the latter vaso-motor bronchitis. He subsequently reported 88 cases of asthma with intranasal lesion, of which 42 were cured (or nearly 52 per cent.), 33 improved, and 2 unimproved. This corresponds closely with the reports of Schmiegelow and Heyman. Bosworth's view of the etiology of asthma has been strongly combated by B. Robinson, Shurly, Ingals, J. N. Mackenzie, and others in the discussions which followed the reading of his papers. It is the belief of the writer that Dr. Bosworth has enunciated the proper theory in drawing close analogy between hay fever and asthma; but in saying that a local nasal lesion always enters into the chain of causes, he seems to have overshot the mark in each case. While the writer's experience is much less extended than Dr. Bosworth's, he certainly has seen cases in which no nasal lesion was present, and few cases of the trouble in which an entire and permanent cure resulted from intranasal operations on existing lesions. A rhinologist cannot from his own experience alone discuss this question intelligently, because the cases of asthma that seek him are those especially which have intranasal symptoms. We see this exemplified in the statement of Lublinski, who said that of 143 cases of asthma with nasal and pharyngeal lesions treated by operation, 27 (less than 20 per cent.) were cured and 13 improved. This experience was gained in a general medical clinic. Heyman, on the other hand, in a nose-and-throat clinic, saw 53 cases and cured 29 (more than 50 per cent.) and improved 14; 10 were unimproved. According to Schmiegelow's tables there were among 50 patients, 32 cured, 11 improved, and in 7 no result. Out of the 32 cases reported cured, there were recurrences in 17; and coincident with the return of the asthmatic attacks there was a recurrence of the nasal lesion. Schmiegelow says that the return of the asthma was caused by the recurrence of the nasal lesion. I have stated my reasons, in speaking of hay-fever, for believing that the neurosis is frequently the initial phenomenon, and the polyp or hypertrophy a secondary and resultant lesion. Schmiegelow's statistics show that his material was made up of 517 cases of chronic rhinitis, of which 40 had asthma (8 per cent.), and 139 cases of nasal polypi, of which 31 had asthma (22 per cent.). These proportions certainly seem very high.

Brügelman distinguishes 5 kinds of asthma, according to their etiology: 1. Nasal asthma. 2. Intoxication-asthma (carbonic oxid). 3. Pharyngolaryngeal asthma. 4. Bronchial asthma. 5. Neurasthenic asthma. Bollinger relates a case in which asthma apparently was caused by the presence of a rhinolith in the nasal chambers, and ceased after the expulsion of it. Roquer y Casadesus reports a case of asthma from an enlarged lingual tonsil cured by its abscission. Glasgow relates a curious instance in which a case of spasmodic asthma was cured by the accidental application of a 50 per cent. solution of carbolic acid to the larynx. From this and other experiences he believes that the larynx, as well as the nose and other organs, may be the starting-point of the reflex. We have already quoted the remark of Dr. F. I. Knight, that he had seen a case of hay-fever cured by the patient's breaking his leg. Cases have been brought forward to show the connection between various manifestations of neurosis of the skin, as urticaria, and circumscribed edema and asthma.

Treatment.—From this short review of the subject, whatever may be the reflex path from the nose to the bronchioles, whatever may be the proportion of the nasal reflex to other reflexes in the causation of asthma, it is clear that when lesions do exist in the upper air-passages, they should be thoroughly and carefully treated; but whether such lesions exist or not, the patient's other organs should be examined with care. Systemic dyscrasia, lithemia, gout, rheumatism, and the general neurotic tendencies must all be considered. The nose is only one wheel with many cogs in a complicated and mysterious mechanism.

An instance of the coincidence of marked naso-pharyngeal adenoids with severe asthmatic attacks which I treated several years ago, has taught me not to be too sure of the dependence of asthma on the nose for its origin. The patient was a young woman of considerable personal attractions, but with a most disagreeable "dead voice." She complained of violent attacks of asthma, somewhat dependent upon the climate and environment, and of constant nasal occlusion not dependent on either. The nose was narrow and the naso-pharyngeal vault filled with a mass of lymphoid tissue. I was cautious enough to make a guarded prognosis in regard to the asthma; but I was sure in my own mind that I would cure her of it. I removed the adenoids perfectly clean from the naso-pharynx, and incidentally had a copious secondary hemorrhage. She, of course, was greatly relieved of many symptoms, but not of her asthma; for, after a somewhat lengthy interval, it returned. I saw little chance of benefiting the nose, and refused further nasal treatment. She went for a long time to a very skilful colleague, who burned and cut the nasal mucous membrane. This was five years ago. Since then she has been married and has had a child, and although her general health has been fairly good, her asthma still troubles her at irregular intervals. A gynecologist has also tried his skill successfully on some sensitive spot, but she had a particularly bad time with the asthma last summer. Her nose is in as good a condition as possible.

To know the ultimate result of these nerve-shocking operations, one must compare the conditions of a long time before with those of a long time after them.

Paroxysmal sneezing may be claimed by the rhinologists as their reflex, since the physiological act usually receives its impulse from the nose. Sam Weller, it will be remembered, when asked by the footman if he took snuff, replied, "Not without sneezing"; but we must remember that bright sunshine, through the eyes, or erotic emotions, through the genital tract, may, in a physiological state, start the reflex. Lennox Browne reports a case of paroxysmal sneezing during pregnancy, beginning at the third month and lasting till term; while Herron reports a case from eye-strain. A case is reported where manipulation of a diseased eye, preliminary to extirpation, caused violent sneezing in chloroform-anesthesia. The sneezing was only avoided by dropping cocain in the eye.

Ringer and Morrell have gone over the literature of the subject and reported many cases; while Crickmay, Balfour-Graham, Hurley, Williams, and "F. R. C. S.," in a series of short notices, make various suggestions as to treatment.

Several years ago, a young woman applied at one of my clinics for relief from prolonged and frequently recurring attacks of sneezing. The middle turbinal on the left side was hypertrophied and pressed against the septum, and there was a large spur which occluded the nostril on the right side. As she complained of irritation in the left nostril, and palpation of the middle turbinal with the probe excited severe sneezing, the mucous membrane with some of the bony structure was removed. The operation was a rather severe one. She returned in about three months, saying that she had been entirely free of the trouble until the last few weeks, when it had begun again and was becoming as bad as ever. The spur was removed by trephine and saw from the other side. Both nostrils were now fairly free. The cautery was also used to reduce the vascularity of the inferior turbinal bodies. Another period of several months passed without any sneezing. It then began again and became worse than ever. She said that the paroxysms would sometimes last for an hour, and she would be so exhausted that she would have to take to her bed. She was apparently, but for her distressing trouble, in very fair general health. The paroxysms seemed to bear some relation to her catamenial periods, and I suggested that she should go to the gynecologist for an examination. She refused, and I did not see her again.

I remember a boy playmate, with congenital heart-trouble, it was said, who would be seized with uncontrollable fits of sneezing lasting many minutes. This would excite our hilarity to a high pitch. When his fit had left him he would join in the fun, and his paroxysm of laughing would also be prolonged and apparently uncontrollable. Another peculiarity about him was his liability to drop suddenly to sleep, even while standing. His mental capabilities were not limited, although rather below the average. Twenty years afterward I heard of him as alive and well; but I do not know whether his reflexes are still as active.

Cough has been repeatedly found dependent upon intranasal disease alone; although the usual extrapulmonary sites of the reflex (see page 709) are in the pharynx and larynx, set up by the various lesions of these regions.

Glycosuria.—Bayer[1] relates the history of a case in which nasal obstruction and post-nasal catarrh were accompanied by glycosuria, which disappeared on the relief of the intranasal condition.

Two years ago I operated on a boy of fifteen for an adhesion of the inferior turbinal to the bony septum throughout its entire length. The operations occupied three or four different sittings, with intervals of a week or ten days. He was previously in good health, except for the distress of nasal obstruction, which was increased by the presence of post-nasal adenoids. Large pieces of bone and mucous membrane and the lymphoid tissue from the naso-pharynx were removed. The boy bore the operations with great fortitude, and they were successfully and satisfactorily performed. For a month or six weeks he had to wear a gutta-percha plate in his nose to keep the bare bony surfaces apart. Before all the lymphoid tissue was removed from the pharynx he began to be languid and pale, and complained of frequent urination. Examination of the urine by his family physician, a distinguished and skilful man, revealed the presence of a small amount of sugar and that he was passing large amounts of urine daily. Local treatment was suspended, and he was put on tonics and sent to the country. After two or three weeks the sugar had disappeared; and after two or three months the urine came back to its normal amount and his general health was restored. I believe that here we had a glycosuria due to nervous depression from the shocks of repeated operations, which, while not very painful, were trying to the general nervous system.

Salivation is referred to by Bosworth as having been cured by intranasal treatment in two cases of elderly people. The list of neuroses occasionally ascribed to lesions of the nasal cavities includes esophageal spasm, hiccough,[1] spasmodic croup, aphonia, asthenopia, strabismus, blepharospasm,[2] migraine, chorea, epilepsy, vertigo, aprosexia, dyspepsia, exophthalmic goiter, acne, erythema of the skin, neurasthenia, and melancholia. This by no means exhausts the array of distant ills charged to the nose.

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[1] *Revue de Laryngologie,* No. 19, Oct. 1, 1894.

If the nose is such a fertile organ in the production of the misfortunes of its brother organs, it also has to bear troubles which are transmitted to it from the gastro-intestinal and the genito-urinary tracts, causing vaso-motor disturbances, post-nasal catarrh, epistaxis, and sneezing.

SENSORY NEUROSES OF THE PHARYNX.

Anesthesia of the pharynx is occasionally observed in cerebral apoplexy, tumors, gummata, scleroses, general paralysis of the insane, etc., and in similar bulbar lesions. It is also present in a marked degree in extreme debility from anemia, phthisis, chorea, etc., and after epileptic convulsions. Certain drugs (chloral, bromids, cocain) produce it. Schmidt has noted unilateral anesthesia of the pharynx and larynx combined with anesthesia of the skin in a case after exposure to severe cold. McBride speaks of cases of carcinoma of the base of the skull in which there was hemianesthesia of the pharynx and larynx. Schech speaks of its occurring after influenza, and he refers to a report by Jurasz of its occurring after pneumonia. All these, however, are the exceptional causes of pharyngeal anesthesia. It usually presents itself as a sequel of diphtheria or as one of the manifestations of hysteria.

Besides these abnormal instances of the occurrence of anesthesia, we have a widely varying degree of sensitiveness of the pharynx in healthy individuals. Some patients bear surprising manipulations in their throats without evidence of pain or discomfort, although these great differences depend probably more upon differences in reflex excitability than in the real susceptibility to tactile or painful impressions. Women, as a rule, have more tolerant if not more anesthetic throats than men; and it has certainly been impressed upon me that neurotic people, those of nervous temperament, when once their first timidity is allayed, are more tolerant than others of the use of the laryngoscope.

Hyperesthesia is more common in men. They not only bear pain less stoically, but they evidently feel it much more than women. Fat persons of both sexes, but especially men, have more sensitive throats. Drinkers, especially of malt liquors, even when not excessive in their libations, are difficult subjects to examine or to operate on. The naso-pharynx is much more sensitive than the lower pharynx. Hyperesthesia is rarely a symptom of central lesions, but always accompanies local inflammations, such as pharyngitis or tonsillitis. The tongue is frequently hyperesthetic in spots. Careful inspection, if necessary with a magnifying glass, will usually disclose a swollen papilla. This will frequently give rise to great apprehension on the part of the patient that he has a beginning malignant growth.

All these hyperesthetic, as well as paresthetic, symptoms are observed in the habitual perusers of newspaper advertisements of quack nostrums and the execrable lucubrations of the imaginative reporters of the public press.

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[1] Abramson, *Journ. of Laryng.*, 1890, p. 216, reports two cases of hiccough, apparently dependent upon granular pharyngitis. These are the only cases that I can find in literature in which the origin of the reflex seemed to be in the respiratory tract. Indeed, the oro-pharynx may be considered as belonging to both the respiratory and the digestive tracts. Hiccough in severe forms is usually supposed to originate in the latter (Benedict, *Atlanta Med. Weekly*, Mar. 3, 1895).

[2] For the literature of ocular reflexes, see the full bibliography given by White (*Burnett's System*, etc., vol. ii. p. 129).

Paresthesia.—While the hyperesthesia and anesthesia of the pharynx are, as a rule, of little clinical interest, paresthesiæ are not only of exceedingly common occurrence, but very frequently baffle the skill of the diagnostician and disappoint the hopes of the operator. They are frequently due to tonsillar disease (not necessarily hypertrophy), to abrasions from the food or the foreign bodies in it, which leave no visible mark of injury to the mucous membrane as they pass over it; but they are, above all, more frequently observed at the time of the menopause in women, and in those who have slight or marked hyperplasia of the so-called lingual tonsil. Now it is an undeniable fact that many persons have a large amount of lymphoid material at the base of the tongue which rubs against the epiglottis and the side of the pharynx, who present no clinical manifestation of the condition; perhaps the larger number give no symptoms. We must therefore admit other and more important factors. These are supplied by the hyperexcitability of the sympathetic nervous system. An elongated uvula is a common cause of abnormal pharyngeal sensations, and its abscission affords the most satisfactory results of any operative treatment for the affection.

Granular pharyngitis of the posterior wall, so far as my observation goes, never by itself gives rise to any symptoms. It is, however, an irregular lymphoid hypertrophy of the mucous membrane, and when this extends to the lateral walls and invades the movable posterior pillars of the fauces it produces an attrition of surfaces, which frequently gives rise to the most marked of the symptoms under consideration. The "globus hystericus," the feeling of a hard, round body moving in the throat and an irresistible inclination, yet an inability, to swallow, is not infrequently seen at the menopause or in young women. I have seen it once in a young man. It is not necessarily an indication of hysteria. A feeling of cold or a burning heat is sometimes experienced by the patients: a feeling of a foreign body, a hair or a bone, a tickling or itching sensation is, however, the usual complaint. Occasionally this is so marked as to induce distressing cough and esophageal or laryngeal spasm. This is also to be sharply distinguished from hysterical manifestations. It is seen in neurotic states which nowadays we like to call neurasthenia. Rheumatic and gouty diatheses, and especially dyspepsia, are fertile sources of these neuroses. They may be due to nasal obstruction, and may accompany and aggravate cough from laryngeal or pulmonary disease.

Treatment.—Careful search must be made for local causes, and when found they must be removed. The crypts of the faucial tonsils must be destroyed by the galvano-cautery. If large enough to cause attrition of surfaces, the lingual tonsil must be reduced in size by the guillotine or cautery. I must confess to many disappointments in this treatment of the trouble. Applications to the base of the tongue of nitrate of silver—gr. x : ℥j—has been perhaps the most successful. This should be done twice or thrice a week. An astringent gargle—

℞. Tr. kino,
Tr. catechu,
Glyc. tannin, *āā* ℥j;
Ol. gaultheriæ, ʒj—

used with cold water, and half-swallowed and brought up with a gulp, so as to give the throat a course of gymnastics, will often benefit these patients.

This is a method of gargling urged by Swain, following v. Tröltsch, and is really the only efficacious way. Hygienic and tonic treatment are indicated in the neurotic cases. Uvulotomy should always be performed when it is seen that the tip of the uvula rests, when relaxed, upon the epiglottis[1] or base of the tongue. Frequently its tip, formed exclusively of the mucous membrane, will be folded or curled up, at the time of the examination, in such a way that the use of a probe will alone disclose the condition. Lateral pharyngitis must be treated by canterizing or cutting off irregularities of the surface. Usually, however, the mucous membrane in this situation is diffusely and uniformly infiltrated. The treatment of diseased faucial tonsils below, and of the pharyngeal tonsil or nasal obstruction above, will frequently cause this lateral pharyngeal infiltration or congestion to subside. Sometimes, however, it persists. Linear superficial cauterizations may be of benefit; but they always cause great dysphagia, and should be resorted to only after other treatment has been tried unsuccessfully. In middle-aged women it is well to explain to them the dependence of their symptoms upon the menopause, and tell them frankly not to expect much relief from local measures or medicines, but from time. Many will be satisfied, but some will seek advice elsewhere. A vigorous local treatment in these cases always results in disappointment to the patient and ultimate loss of prestige to the doctor. The patients are frequently importunate in their demands and obstinate in their belief of some pathological condition which exists only in their imagination.

Neuralgia of the pharynx is a Greek term for a pain in the throat for which the observer can find no visible or tangible explanation. It is sometimes called myalgia. I have frequently had patients complain of great dysphagia and give every evidence of suffering, in whom I could discover no pharyngeal lesion. These cases are seen more frequently in cold weather, when throat inflammations are rife. I am under the impression that in some of these cases at least we have a condition analogous to what is known as muscular rheumatism. Although there is constant pain, there is usually little tenderness to pressure unless it excites muscular contractions.

A saline purge and a gargle of bicarbonate of soda, one dram to a half ounce, in a glass of hot water, often gives some relief. The trouble usually passes off of itself in a few days. It is sometimes ascribed to a gouty or rheumatic diathesis. Morell Mackenzie refers to more chronic cases occurring in young women. Some of them suffered from anemia or chlorosis; but many were healthy and usually not hysterical. He recommends the local application of the tincture of aconite twice or thrice daily. Massei recommends the galvanic current.

MOTOR NEUROSES OF THE PHARYNX.

Spasm.—Tetanus, hydrophobia, tabes dorsalis, and hysteria are the usual causes of this rare affection. It is said to be occasionally seen in acute and chronic inflammations. Lennox Browne, in his paper[2] on pharyngeal tenesmus in 1891, seems to refer to cases which we are accustomed to include among the paresthesiæ, giving prominence as a cause to the lingual varices, about which we have read so much in English journals recently. Spasm of the pharynx has been reported by Bewley in a case of lesion of the fourth cerebral ventricle, in which there was apparently also a paralysis of the esophagus. Seifert speaks of having seen clonic spasm of the soft palate with subjective tinnitus aurium in a case of hypertrophic rhinitis; while the same symptom was observed by Spencer in a case of cerebral tumor.

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[1] The uvula should not touch the laryngeal surface of the epiglottis (see legend of Fig. 534).

[2] *Archives de Laryngologie*, Feb., 1891.

Pharyngeal Paralysis.—Diphtheria causes the majority of the paralyses of the palate and pharynx; but it is occasionally seen as a result of a simple acute inflammation, as mentioned by Jurasz, who also speaks of three cases in which the cause was unknown, one in which it was due to a bulbar paralysis, and one in which it followed cervical glandular swelling. I have seen one case[1] in which it was due to a syphilitic lesion, evidently of the floor of the fourth cerebral ventricle. It was unilateral and accompanied by lingual paralysis and atrophy and posticus laryngeal paralysis. I have also seen it in a fatal case of peripheral neuritis as the initial symptom of the involvement of the muscles of deglutition and respiration.

Besides the case of Jurasz, cases are referred to by Morell Mackenzie and others, which were reported before we depended upon bacteriology for our diagnosis, in which it was supposed to be caused by simple but severe angina. Bourges lately reported it after a case of membranous pharyngitis, in which bacteriological examination had not revealed the diphtheria-bacillus, and refers to its occasional occurrence after other diseases (typhus and pneumonia). He says it may be produced in animals by injection of streptococcus and pneumococcus toxins. I have also seen a case in which it was said the bacillus of Löffler could not be found. However, a negative bacteriological report is seldom conclusive. The **symptoms** are those of nasal speech and the regurgitation of food into the naso-pharynx. An examination shows the palate and pillars of the fauces relaxed and unable to respond to tickling with a probe. Mucosities may cover the posterior wall of the pharynx and cause the patient great annoyance. The **prognosis** is bad when due to central lesions, except in recent cases due to syphilis, when the vigorous administration of the iodid of potash may restore power to the muscles. Cases of peripheral pharyngeal paralysis nearly always get well of themselves. Strychnin and galvanism are the therapeutic measures employed; but I am not sure that they hasten matters at all, except that strychnin is an efficient tonic.

For a full account of the neuroses of the soft palate Rethi's excellent work[2] may be referred to.

NEUROSES OF THE LARYNX.

Sensory Neuroses.—**Anesthesia** of the larynx arises from the same causes as anesthesia of the pharynx, and is usually accompanied by it. Schnitzler speaks of it as occurring especially in anemia of the larynx.

Hyperesthesia, as in the pharynx, is usually present in the various forms of acute and chronic inflammation.

Paresthesia manifests itself usually by a tickling sensation, a feeling of a hair or other foreign substance in the larynx. It is commonly due to some abnormality of the laryngeal mucous membrane; but very frequently sensations are referred to the larynx by the patient, which have their origin in some slight lesion of the pharynx (Jurasz). All these sensory neuroses of the larynx are observed in hysteria.

Neuralgia of the larynx has been reported by Chapman in four cases as due to malaria, and cured by anti-malarial treatment; but from his account of the cases the diagnosis seems to be a little uncertain. It is said also to be due occasionally to gout or rheumatism; but we may safely conjecture that in such cases it is really due to some slight involvement of the crico-arytenoid joint. One such case I have seen, when in a normal-appearing larynx pain was produced by pressure on the cricoid cartilage. In this case the exhibition of salol for a few days gave entire relief. Bosworth reports a case of his own in which, in a neurotic patient, severe pain in the larynx was due to an acute naso-pharyngitis. He refers to a report by Schnitzler of excruciating pain of the larynx and pharynx following an angina. Bosworth's case was cured by aconitin, gr. $\frac{1}{500}$, and Schnitzler's by local applications of chloroform and morphin.

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[1] *N. Y. Med. Journ.*, Sept. 28, 1889.

[2] *Motilitäts, Neurosen des weichen Gaumens, eine klinische Studie*, Vienna, 1893.

Motor neuroses of the larynx are to be divided into spasm (hyperkinesis), paralysis (hypokinesis), and incoördination of the laryngeal muscles. Space does not allow here of a consideration of the anatomical action and physiological function of the laryngeal muscles, nor of their innervation, nor, indeed, of a full review of the somewhat acrimonious discussion of the pathogenesis of the various motor neuroses, which for several years produced such a voluminous literature of the subject.

Spasm may affect any of the laryngeal muscles, and cases are occasionally reported in which there was spasmodic contraction of the abductors alone; but it is probable that this is always accompanied by, if not always the result of, paralysis of the adductors of the larynx.

Spasm of the adductors is sometimes divided into phonatory, deglutitory, and respiratory. Phonatory spasm is a rare affection in which the spasm of the adductors comes on only with attempts at phonation, preventing it, but not materially interfering with respiration. Deglutitory spasm of the laryngeal adductors is that form which supervenes whenever attempts are made to swallow, sometimes only fluid, sometimes only solid food, while in other cases the spasm is produced by *any* attempt at swallowing.

Usually by spasm of the larynx is understood the contraction of the adductors, producing a closure of the glottis which interferes more or less seriously with respiration. The most important and the most frequent of these cases present the well-known phenomena of spasmodic croup in children.

Laryngismus stridulus occurs most frequently in poorly nourished, if not always rachitic, children. The percentage of cases in which rachitis is an etiological factor is variously estimated by different authors from 50 to 90 per cent. Various theories have been advanced to account for the connection between the affections. Pressure on the medulla from softening of the cranial bones, or the presence of enlarged bronchial glands pressing upon or irritating the vagus or recurrent nerve, do not satisfactorily account for it. Heredity seems to have some influence. It is, however, not infrequently observed in apparently perfectly healthy children as the result of catching cold or disturbances of the stomach and bowels. Enlarged naso-pharyngeal and faucial tonsils occasionally seem to be the sole cause of attacks which differ in no way, except in severity, from those seen in rachitic children, and removal of the tonsils promptly relieves the symptoms. Occurring most frequently in male children from six months to three years of age, it is also seen both before and after this period. It usually occurs in the winter months, and the attacks come on more frequently at night.

Symptoms.—The little patient suddenly starts up from his sleep, gasping for breath, the face becomes livid, for many seconds respiration stops, and the child may become unconscious and death may at once ensue; but usually the respiration begins again in gasps and gradually becomes normal. Cold sweat stands out on the face and the heart's action is much reduced. The whole attack may be over in a few minutes, or it may be prolonged and repeated several times in one night; and there is usually recurrence for several nights in succession.

Treatment.—The physician rarely gets to the patient in time to apply remedies, and the parents or attendants are usually too frightened to follow any directions that may have been given. The application of cloths wrung out of very hot water, or out of ice-water, to the anterior cervical region may shock the laryngeal muscles into good behavior for a time. A hypodermic injection of morphin, or the injection of a few drops of chloroform into the rectum, may cut short the attack. If possible, an efficient emetic may be given, as the yellow sulphate of mercury. The prophylactic treatment is proper hygiene, the administration of cod-liver oil, and the removal of lymphoid hypertrophies from the fauces and naso-pharynx.

Bosworth sharply differentiates the cases occurring in rachitic children from others. The death-rate is high among the former and low in the latter cases. He claims that in the latter cases we have a glottic or sub-glottic inflammation of the mucosa. This may be so, but the condition has been found post-mortem in the former cases; while the laryngoscope cannot, as a rule, be used to establish the diagnosis in any of the cases during life. The symptoms which give gravity to the affection are not inflammatory, but spasmodic. Sickly children cannot stand the sudden strain thrown on the lungs or heart by the spasm so well as robust children. I presume this is at the bottom of the apparent difference in the gravity of the cases.

Laryngeal Spasm in Adults.—While laryngeal spasm in children presents a fairly uniform clinical picture and is due apparently to a limited number of causes, the opposite holds true in adults. Notwithstanding its comparatively infrequent occurrence, we find cases reported as due to hysteria, to various local lesions of the nose and throat, to reflexes from other organs, and to lesions of the nerve-trunks and centers. It may occur at any time of the night or day or under various conditions of health and disease. It may be phonatory, deglutitory, or respiratory. The following remarkable case is reported for the first time, I believe, although it occurred many years ago in the New York Hospital.

The patient was an unmarried woman of thirty-two. Her father died of spinal meningitis. She had had a left pneumonia twice, inflammatory rheumatism, and some disturbances referable to her stomach, bowels, and kidneys. Since the last attack of pneumonia, five years previously, she had had a slight, persistent cough. Six years previously she had had a small tumor removed from some part of her throat, and after two years two more were removed. She knows nothing of their nature or situation. She had had at times some shortness of breath, but never any excessive dyspnea or aphonia until a few weeks before her admission. She had used morphin hypodermically for neuralgia, but was not an habitué. Four weeks ago she had caught cold, and since then the cough had been troublesome, and she had occasional dyspnea and aphonia. On the day of admission, after a hearty meal she had started for a walk feeling as well as usual; but soon experienced a feeling of constriction of the throat, and breathing became difficult. Being near the hospital she came directly there. She was restless and excited. Her breathing became more involved in spite of morphin by the mouth, inhalations of amyl nitrate and ether, and "faradization of the pneumogastric." She became unconscious three-quarters of an hour after admission; respiration was practically suspended. She was cyanosed, and her pupils contracted. Artificial respiration being of no avail, laryngo-tracheotomy was done. The introduction of the tube was not followed by any signs of tracheal irritation or spasm, but after a few moments respiration began. At first, it was only six to the minute. She remained unconscious for six hours, when the respiration having arisen to sixteen and being "Cheyne-Stokes" in character, she had a severe attack of coughing and became conscious. Fifteen ounces of urine were drawn by catheter and found to be pale, 1008, albumen 2 per cent., no casts. For two weeks she suffered from sepsis due to a hypodermic abscess with sloughing. Her general condition finally became normal, except that she was hysterical in many ways. No pulmonary signs of importance were noted; but she had considerable gastric disturbance. The albumen soon disappeared from the urine. About four weeks after admission she had a very severe attack of coughing combined "apparently with bronchial spasm;" and for several weeks had such attacks lasting from thirty seconds to a minute, during which she struggled for air and became cyanotic. They would subside as suddenly as they came (hysterical?). After a time her condition improved and she had no more attacks. Dr. Lefferts examined her larynx and pronounced it absolutely normal. She was discharged from the hospital after the removal of the tracheotomy-tube.

Five or six years afterward this patient came under my observation for attacks of aphonia, evidently of hysterical origin. In the meantime she had no return of any laryngeal spasm.

I can offer no explanation of this case. Certainly we do not expect hysterical spasm to persist when the patient becomes unconscious and as near death as this young woman was; and yet hysteria was the salient feature in the laryngeal and other manifestations. Leo relates a case in which death ensued in a young man, which he thought was due to hysterical spasm of the larynx; although the history of the case leaves the reader in doubt as to the correctness of the diagnosis. Chaput reports a case of hysterical laryngeal spasm cured by tracheotomy; and Landgraf, one cured by catheterization of the trachea. All these cases were in men. Irwin relates a case where laryngeal spasm occurred in an adult, arising by reflex action from a bullet lodged in the arm. Removal of the ball cured the case. Foreign bodies in the nose, nasal tumors, gastric disturbances, irritation of the recurrent or vagus by tumors, are noted among the causes of respiratory laryngeal spasm. I have seen several cases in which an aneurysm of the arch of the aorta produced dyspnea, evidently rather by involvement of the recurrent causing laryngeal spasm than by pressure on the trachea or bronchi. Epilepsy, chorea, tetanus, and hydrophobia are the general nervous affections of which laryngeal spasm is the more or less constant accompaniment. As Gottstein remarks, it occasionally occurs in cases in which no explanation can be found.

Moure, in describing laryngeal spasm, divides the etiology into functional, directly irritative, peripheral, central, reflex, and associated with general affections. The form of laryngeal spasm we are most familiar with results from the impact of foreign bodies and local applications in the treatment of laryngeal affections.

Symptoms.—Long-drawn whistling inspirations and short expirations, with anxious face, drawn features, and cyanosed lips make an unmistakable picture of obstruction of the air-tube; while its sudden advent and intermittency indicate its spasmodic character. The obstruction is rarely so great as to completely stop the respiration, as in the cases narrated above. The attack may be a single one, or often repeated for days or months. The patients usually recover; but some of the diseases that give rise to it, as tetanus, hydrophobia, tabes dorsalis, are in themselves fatal. It is not often possible to observe the larynx during one of these attacks. In the examinations that have been made there has been noted sometimes only closure of the true cords, but sometimes of the false cords, which hides the condition below.

Treatment.—Tracheotomy or intubation may be necessary to avoid immediate suffocation; but otherwise therapeutic measures must depend, as does the diagnosis, upon the cause of the affection.

Nervous cough, or **chorea of the larynx,** is an associated tonic spasm of the glottis and of the other respiratory muscles, resulting in a more or less rhythmical and continued cough or bark, which is only regularly absent during sleep. It has been most frequently noted in girls at the time or shortly after the advent of puberty; but it has also been noted before this period and at a more advanced age. In one case reported by Holden it occurred in a man of fifty-seven. F. I. Knight recorded a case in a woman of forty-two; other cases have been noted by Lefferts, Roe, Morgan, Schnitzler, Wheeler, Mandel, Porcher, Furundena-Labat, Tamburini, Kinnicutt, Masucci, and Clark. Gottstein, Massei, Schmidt, and Schrötter have discussed the nature and etiology of the affection thoroughly in their works. Some cases seem to have been due to reflex causes; but since the majority of the cases as to age and sex are grouped around the period of the advent of puberty in women, we may conclude that the phenomenon is usually due to the nervous developments peculiar to that time. Hysteria, as usual at this period, is a prominent factor in some of the cases. These cases are usually reported under the head of laryngeal chorea; but it is exceedingly doubtful if it has any close relation to this affection, since very few of the cases were accompanied by any of the other choreic twitchings. The cases reported have excited the interest of physicians and the wondering curiosity of friends. Many have been known as "barking girls," and the incessant noise has rendered them a nuisance to their companions and made their own lives miserable. Fortunately, after a varying length of time the trouble disappears. The cough or bark may be repeated at intervals of a few seconds or minutes throughout the entire day or be only present for a short time, or there may be periods of days or weeks in which it is absent. It is always absent during sleep. On laryngoscopic examination the vocal cords are seen to be driven toward the median line, apparently by an uncontrollable spasm of the adductors. Knight states that in a case observed by him he could distinctly hear the click of the cords as they met. The air is driven out through the narrowing glottis by a corresponding contraction of the diaphragm, producing a short, sharp yelp or bark, terminating abruptly from the firm closure of the glottis. This is repeated at intervals varying from a few seconds to ten or fifteen minutes.

Treatment.—Local treatment is of little avail, and the bromids and narcotics have no curative value. The moral effect of authority, fright, galvanism, the mind-cure, faith-cure, or any of the other so-called hypnotic influences may suddenly terminate the neurosis. Of course, the general hygienic treatment by tonics, outdoor life, proper diet and sleep, and relief from any nervous strain, must all be insisted upon.

Inco-ordination of the Laryngeal Muscles.—(*Dysphonia* or *Aphonia Spastica; Aphthongia Laryngea* (Gottstein); *Phonatory Spasm*).—This is a curious laryngeal neurosis which has occasionally, although rarely, been noted. It seems to be in some cases a manifestation of hysteria; and in some cases has occurred from overfatigue of the larynx in preachers. Any attempt at phonation results in a more or less complete closure of the glottis, so that not a sound comes forth; and with it may be associated some respiratory spasm—that is, the adduction of the vocal cords lasts long enough to cause inspiratory dyspnea. In other cases there comes a high-pitched, shrill note from the larynx, possibly articulated, but not long sustained. A familiar example of this inco-ordination of the phonatory muscles is the changing voice of boys at puberty.

With the laryngoscope no abnormality is to be observed until the patient attempts to phonate, when the vocal cords are seen to be firmly apposed in the median line.

Functional inspiratory spasm of the glottis is sometimes associated with the phonatory spasm, or it may exist without the trouble in phonation. When attacks of inspiratory dyspnea occur, it is seen on examination that the glottis is narrowed on expiration. The cords may be in apposition except at their posterior end, where there exists a three-cornered opening, from which we may suppose that the interarytenoidens muscle is not involved in the spasm. We may look upon these cases as evidences of perverse innervation—*i. e.*, the inspiratory impulse starts along its accustomed path to the abductors and is switched off to the adductors; but the cases have not been numerous enough to furnish data for study, and no theory satisfactorily explains them. Schnitzler first fully described the affection, and it has been discussed in the works of Schrötter, Gottstein, Moure, Bosworth, and Mackenzie; while cases have been reported by Onodi, Jendrassik, Jonquière, Meyer, Schnitzler, Landgraf, Sanctis, and others.

It occurs in adults, both men and women. In the latter it frequently depends upon hysteria, but in many cases no cause can be assigned. Mackenzie, Gottstein, Schrötter, and others have met with cases that have lasted for years without relief; but most of the hysterical cases have recovered.

Treatment.—Reflex causes must be sought for and remedied if they exist. The general health, if faulty, must be improved. Hysterical cases have been cured by suggestion, faradization, etc. Jonquière and Meyer cured some cases in hysterical women temporarily and others permanently by pressure on the ovaries.

Ataxia, nystagmus, and rhythmic movements of the vocal cords have been observed in tabes dorsalis, chorea, hysteria, cerebro-spinal meningitis, and paralysis agitans.

Mogiphonia is a term used by Fränkel to describe laryngeal phenomena induced by overuse or strain of the voice. It may be of a spastic form—phonatory spasm of the larynx—a tremulous form, or a paralytic form. The last-named has been noted by Fränkel and Bresgen in singers, preachers, and teachers. It is peculiar in that the voice may be used for other purposes, but phonation fails when they attempt to use the voice in the accustomed way—singing, preaching, teaching, etc. I do not find that others have used the term.

Laryngeal Vertigo.—Ictus laryngea, laryngeal epilepsy, laryngeal crises, laryngeal syncope, or lipothymia laryngea are synonyms for an affection which has not as yet been satisfactorily classified, although it has been recognized for twenty years. I have chosen the name laryngeal vertigo as a heading because that is the term under which most of the cases have been described in the English language, ictus laryngea being the name under which the affection is usually noted in other tongues. It is, however, neither a vertigo nor an epilepsy; since the cases reported have rarely suffered from the former and, except in two cases (Gray and Bianchi), have never presented any other manifestation of the latter. After a careful study of the reports it would seem that laryngeal syncope (lipothymia laryngea), the term used by Kurz, is the least objectionable. Laryngeal vertigo was first described in 1876 by Charcot, under that name. Since then there have been numerous reports in French and English, but there are few accounts of cases in German. Garel and Collet have given the best and most exhaustive description of it, reporting 23 cases of their own. With the exception of two or three cases, all have been in men; and the majority of them were between forty and fifty years of age.

The patients feel a tickling in the larynx, cough once or twice, and become suddenly unconscious. This lasts for less than a minute, with quiet respirations and a feeble pulse, when they as suddenly regain consciousness and feel as well as ever—often laughing at the alarm the attack has excited in their companions. The face becomes flushed and congested at the beginning of the attack and is pale on recovering. There may be a single attack or a number of them at short intervals or at intervals of years. In some cases there has been evidence of bronchitis and emphysema or of an enlarged and fatty heart. Alcoholism, diabetes, and nephritis have been occasionally noted in these patients, but not frequently enough to make them of much importance in the consideration of the etiology. The patient may have had laryngeal irritation and cough for years, and only once an attack of syncope. He may cough only once slightly or many times violently before he becomes unconscious. Frequently he has been sitting quietly or the attack has come on in bed. At other times he has been walking or driving. In some cases there has been excessive bronchial secretion. Usually there has been no convulsive muscular action during the attack; but in some there has been twitching of various muscles. It is exceedingly probable, as urged by Garel and Collet, that these attacks often occur without the patients remembering them in their accounts, or without their being noted by their companions.

Various theories have been advanced to account for the attacks. Charcot supposed them analogous to Ménière's disease, the superior laryngeal nerve being involved in the intracranial irritation, instead of the auditory. Garel and Collet suppose it due to arterial anemia of the brain, there being an obstruction to the venous circulation and an insufficiency of arterial blood in the vessels due to a temporary weakening of the heart's action. This cardiac failure they suppose to be brought about by the involvement of the sympathetic nerves in the irritation of the superior laryngeal at the time of the cough. In only two cases was the attack observed by the reporter. Kurz found his patient in syncope; while Schadewaldt was looking at his case when one of the attacks began. This case subsequently died in one of the fits; but, as a rule, this has not been noted, nor does it appear necessarily to be an indication of disease of a vital organ. Gleitsmann's case had enlarged lingual glands, and the treatment of these abolished the attack. Adler attained the same result by clipping an elongated uvula, and Charcot by cauterizing a granular pharyngitis.

The cases are really more curious and interesting than instructive or important, since we are unable to classify them, and since they apparently are only exceptionally brought to the notice of the physician.

Treatment.—Local abnormalities must be sought for and removed, and the systemic diseases which may be present must receive their appropriate treatment. Drugs have no direct influence on the attacks.

Laryngeal Paralysis (Hypokinesis).—Pathology and Etiology.—Central paralysis of voluntary motion in the majority of cases is caused by some lesion of the cerebral cortex. Paralysis of involuntary motion in the majority of cases has its origin in the spinal cord or the medulla. Phonation is the product of voluntary, and respiration is the product of semi-involuntary, motion. Aphasia must be entirely separated from aphonia in the consideration of its etiology. Shortly after interest was first aroused in the location of areas of the origin of motor impulses in the cerebral cortex, Krause, in 1884, showed that stimulation of the *gyrus prefrontalis* in animals

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produced muscular movements of the larynx, palate, and pharynx. Thereupon Garel,[1] in 1886, reported a case of laryngeal paralysis in which autopsy showed a lesion of this area. Lewin had previously noted the occurrence of laryngeal paralysis in a case of hemiplegia; but Garel's was the first case that had come to autopsy in which a laryngoscopic examination had previously been made. In 1889 Semon and Horsley[2] published the results of their experiments on animals, by which Krause's statements were confirmed. They showed that the area was one of bilateral representation—*i. e.*, a stimulation of either side at the lower part of the *gyrus prefrontalis* would produce adduction of both vocal cords. They also showed that extirpation of one or both of these areas produced no laryngeal paralysis. These results have been confirmed by all observers with the exception of Massini, who claimed that faradization with weak currents produced movement of one side only of the larynx. Several observers have repeated Massini's experiments, with negative results. Garel and Dor later returned to the subject and reported further cases, and cited several from literature in which a cortical lesion was accompanied by laryngeal paralysis; but in none of these cases were they able to exclude a possible lesion of the pons, of the nerve-trunks, or of their peripheral distribution. Hunter Mackenzie's recent case is open to the same criticism. Semon and Horsley showed that the fibers from this cortical area passed through the *corona radiata* and internal capsule to the bulb. They showed also[3] that the respiratory cortical center in animals does not exactly correspond to the phonatory center, and that laryngeal movements were observed independent of thoracic movements of respiration. "Acceleration is obtained by exciting the precrucial gyrus; intensification, most commonly, from the region around the lower end of the crucial sulcus; and inspiration we have already localized in the cat just above the olfactory sulcus." The manifestation produced in a cat by stimulation of this area was persistent abduction of the vocal cords, while thoracic respiratory movements continued. As to phonation, they say that "there is in each cerebral hemisphere an area of bilateral representation of *adductor* movement of the vocal cords situated, in the monkey, just posterior to the lower end of the precentral sulcus at the base of the third frontal gyrus; and in the carnivora, in the precranial and neighboring gyri." The fibres from these run directly through the *corona radiata* to the internal capsule, where "the fibers which subserve the function of respiration are contained at first in the anterior limb and lower down, more especially in the region of the *genu*." "The fibers which subserve the function of phonation, and excitation of which produces adduction of the vocal cords, are, in the carnivora, grouped at, or just posterior to, the *genu*, and also, according to the level of the section, continued into the posterior limb. In the monkey they are concentrated as a small bundle in the posterior limb, among the fibers for the movement of the tongue and pharynx. From excitation of these fibers we have always obtained bilateral effects." They also described laryngeal respiration as represented in the medulla oblongata by an area in the upper part of the floor of the fourth ventricle. Here also unilateral stimulation produces bilateral effect, the prevailing movement being abduction; while adduction or phonatory movement (bilateral) is excited by irritation of the *ala cinerea* and the upper part of the *calamus scriptorius* at the lower border of the fourth ventricle. Irritation of one of the external borders of the restiform bodies produces unilateral adduction of the vocal cords. The authors, in conclusion, admit that they have indicated only the more prominent highways of nervous impulse, and that there may be other contributing paths.

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[1] *Rev. de Laryngol.*, May, 1886, p. 248. [2] *Brit. Med. Journ.*, Sept., 1886; Dec. 21, 1889.
[3] *Deutsch. Med. Woch.*, 1892, p. 672.

Goltz, Onodi, and Klemperer have confirmed these statements, and shown that not only may these cortical centers be destroyed in animals without affecting the innervation of the larynx after the wound has healed, but they and others have proved that the whole of both cerebral hemispheres may be cut away with the cerebellum, leaving nothing but the pons, without affecting the movements of adduction or abduction in the larynx. These facts have been established by experimentation on animals. How far they are applicable to man it is impossible to say, although it is probable that owing to the larger evolution of the brain in man, especially that part of it having to do with speech, variations would be noted in important particulars from the lower animals. As a matter of fact, however, there has been no case reported in man of cortical lesion accompanied by laryngeal paralysis in which the possibility, and few in which the probability, of involvement of the nervous tract below could be excluded. We must, therefore, in view of the positive evidence in animals and the negative evidence in man, admit that Semon's declaration of the non-occurrence of cortical laryngeal paralysis in man is probably correct.

In 1873 Schech and Schmidt, by experiments, apparently established the fact that the vagus gets the motor-filaments which supply the larynx from the upper filaments of the spinal accessory nerve. This view has obtained until lately, when Grabower and Grossman, by separate investigations, showed in 1890 that this was not the case, but that the motor innervation of the vagus was obtained through its lower filaments from the dorsal vagus nucleus in the lower part of the floor of the fourth cerebral ventricle. Darkschewitsch, in 1885, stated that the dorsal nuclei of the vagus and the spinal accessory nerves were coterminous, arising, therefore, from the same tract of gray matter. Grabower and Grossman in 1894, again separately, in a series of microscopic sections, have shown that the motor nucleus of the accessory and that of the vagus are not coterminous, but that the latter begins above where the former leaves off—in the medulla oblongata; and still more recently Grabower has reported a case which goes far, by clinical and pathological evidence, to establish the fact which he had previously announced from experimental and microscopic investigations. A bulbar lesion causing laryngeal paralysis we must, therefore, expect to involve the dorsal motor nucleus of the vagus nerve, which lies near the median furrow, at the lower part and beneath the floor of the fourth ventricle.

The anatomy, course, and distribution of the laryngeal nerves in general have been well understood for a long time; and space does not allow us to dilate upon well-known data. There are several points, however, upon which it is necessary to say a few words, as they have of late been the subject of important investigations. Notwithstanding the fact that Exner has shown that in certain animals the superior laryngeal nerve participates in the innervation of certain of the intrinsic laryngeal muscles, subsequent investigations show pretty clearly that this arrangement does not obtain in man; but that the external or smaller branch of the superior laryngeal nerve alone contains motor filaments, and these supply the crico-thyroid muscle only, the other branches of the superior laryngeal nerve being exclusively composed of sensory filaments (Onodi) which supply the laryngeal mucous membrane. Besides the nerve-supply derived from the superior laryngeal nerve, the crico-thyroid muscle has been shown by Exner, Onodi, and others to receive by means of a communicating branch (middle laryngeal nerve) motor impulses from the pharyngeal branch of the pneumogastric. This has been a subject of considerable controversy; but in a later communication Exner has re-asserted the fact. The other internal laryngeal muscles, adductors, abductors, and tensors are supplied by one nerve—the inferior or recurrent laryngeal nerve. The vagus, running from the jugular foramen with the blood-vessels, dips into the thoracic cavity and gives off the recurrent laryngeal, which winds around the arch of the aorta on the left and the subclavian artery on the right and returns to the larynx.

Rosenbach and Semon at about the same time (1880–1881) drew attention to the fact that in laryngeal paralysis the abductors are usually the first, and sometimes apparently the only, muscles to suffer as the result of central or nerve lesions. In hysterical aphonia, however, it is the adductors which are affected. Attention being drawn to this fact of the preponderance of abductor paralysis, great curiosity was excited as to the cause of this phenomenon. In 1884 Krause, by a number of experiments on animals, was convinced that this apparent paralysis of the abductors, resulting in the immobility of the vocal cords in the median line, was really due to a contracture of all the laryngeal muscles from irritation caused by pressure on the nerve-trunks or nerve-centers, or by their involvement in disease. This raised a point about which for many years much acrimonious discussion prevailed. Semon was the most persistent and the most successful of the opposers of this view; and his papers and references to the question have been voluminous and frequent. Although I was inclined at the time to believe that Krause's experiments had established his contention, and so expressed myself,[1] the weight of evidence has so preponderated against it in the last five or six years, that I cannot but admit that Semon's view is more nearly correct; yet, as the latter has said, one cannot deny that contracture occasionally is the cause of median position of the cords. Various explanations have been advanced to account for the greater proclivity of the abductors to loss of power. Although Mackenzie and Riegel had suggested the existence of separate filaments in the recurrent nerve supplying the different muscles, it remained for Onodi and Risien Russel to demonstrate the fact; but their position in the nerve, as suggested by Mackenzie and Riegel, could not account for the frequency of abductor paralysis. Hooper, in a valuable paper, showed that ether has a peripheral and differential effect upon the laryngeal muscles, the abductors being the first to suffer in their function. Jeanselme and Lermoyez showed that the abductors lose their contractility first post-mortem. Fränkel and Gad showed that freezing the recurrent nerve caused first a paralysis of the abductors. The experiments of Massini showed the same effect from application of chromic acid to the nerves. Mackenzie suggested that the greater exposure of the posterior crico-arytenoids to the passage of food and air made them more liable to injury, owing to their position. From these facts, it seems, as Semon says, that the greater proclivity of the abductors to the loss of power is probably due to the characteristics of the muscles themselves; but it must be confessed that the evidence in this regard is not complete.[2]

From what has preceded, it is not necessary to dwell long upon the causes of laryngeal paralyses. We have seen that we may, in the present state of our knowledge, disregard the few cases that have been reported of lesions of the cerebral hemispheres. Various affections of the medulla oblongata not infrequently produce laryngeal neuroses, together with other peripheral manifestations. Out of 122 cases of tabes dorsalis observed in Gerhardt's clinic, paralysis of the laryngeal muscles was observed in 17. Of these, 11 were of the posticus or abductor muscle of the glottis, 5 were bilateral, 4 upon the right hand, and 2 on the left. There were 3 cases of paralysis of all the muscles supplied by the recurrent—1 bilateral and 2 on the right side. Of the other 3 cases, there was 1 each of recurrent paralysis and of crico-thyroid (superior laryngeal), and once paralysis of the recurrent of one side and of the posticus muscle of the other. In 2 cases paralysis of the thyro-arytenoid was noticed. In 2 of the 122 cases ataxic movements of the vocal cords, and in 4 laryngeal crises, were observed. For a further account of laryngeal affection in tabes dorsalis, see the papers of Burger, Van Gieson,[1] and Dreyfuss.

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[1] *N. Y. Med. Journ.*, Sept. 2, 1889; *Journ. Am. Med. Assn.*, Oct. 8, 1892.

[2] Grabower has, since the preparation of this chapter, adduced evidence to show that the greater vulnerability may be due to a difference in the method of termination of the nerve-fibers in the muscles (*Arch. f. Laryngologie*, Band v., Heft 1.).

Two cases of unilateral posticus paralysis have been observed in syringomyelia by Weintraud, and 1 by A. Schmidt. Paralysis and tremor of the vocal cords have been noted in multiple sclerosis by Leube, Bennett Lori, Collet, Spencer, Krzywicki, and others. In one of Collet's cases the lesion was in the cerebellum. Laryngeal paralysis is one of the symptoms caused by the progressive lesion of the gray nuclei of the bulb, which we call glosso-labio-pharyngeal paralysis, and is said to distinguish it from the pseudo-bulbar paralysis.

The lesions causing these symptoms are usually softening of the nervous matter caused by atheroma of the vertebral artery or its branches. As is readily understood, the sequel of symptoms varies somewhat, depending upon the vessel affected. Syphilis may set up similar changes in the blood-vessels; and the vigorous administration of iodid of potash may stop the progress of the disease, and to some extent restore function to the paralyzed vessels: but of course only a moderate degree of restoration is to be expected. Brain-tissue in this situation is not regenerated, although congestion and the pressure of inflammatory syphilitic products may be relieved. The small laryngeal muscles, when once atrophied, are not usually restored to function. Cases have been reported by Senator, Eisenlohr, Delavan, Wright,[2] Scheiber, and others.

Cases of bilateral laryngeal paralysis are rarely due to bulbar lesions; but, as will be seen by reference to the above instances, a number of cases of unilateral laryngeal paralysis have been found to be due to lesions of the medulla. This does not entirely correspond to the evidence, cited from Semon and Horsley's experiments, of the existence of a bilateral representation of laryngeal movements in the nuclei of the bulb in the lower animals. Evidently the last word has not been said concerning the central innervation of the larynx.

Tumors of the pons and medulla have been rarely reported as causing laryngeal paralysis. Gottstein reviews the subject and refers to the report of several cases of glioma and one case of aneurysm of the basilar artery by Ollivier d'Angers.

All the cases reported of laryngeal paralysis due to bulbar lesion have presented similar conditions in the regions supplied by the facial, acusticus, glosso-pharyngeal, spinal accessory, or other branches of the vagus nerve, according to the extent of the lesion.

Many cases of laryngeal paralysis have been reported due to the involvement of the trunks of the vagus or laryngeal nerves in tumors, traumatism, and other pathological conditions at the base of the skull. As these conditions may simultaneously involve the other nerves referred to, it is often a matter of some difficulty to distinguish them from bulbar lesions. Such are the cases reported by Remak, McBride, and Türck.

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[1] *The Journal of Nervous and Mental Disease*, July, 1896.

[2] *Loc. cit.*

Lesions involving the trunk of the vagus on its way down the neck and of the recurrent as it winds around the great vessels in the thorax and travels back along the esophagus to the larynx, are the most fertile causes of laryngeal paralyses. Enlarged glands, traumatism from wounds and operations, goiters, aneurysms, tumors of the mediastinum, esophagus, and pharynx, pleurisy, and tuberculosis at the pulmonary apices, pericarditis, scoliosis of the cervical vertebra, have all been reported as causing paralysis of the abductors alone or of all the muscles supplied by the recurrent.

In aneurysm of the arch of the aorta, laryngeal paralysis may be the first, and for a long time the only, sign of dilatation of the vessel. Again, cases are not infrequently met with in which no cause can be assigned for the recurrent paralysis, and we are compelled to make a tentative diagnosis of simple neuritis.

We must suppose the rare instances of the paralysis of separate muscles to be due either to lesions of the nerve-twigs supplying them, or to involvement of the muscle-substance itself. As we have seen, paralysis of the abductors is said by Mackenzie to be due in some instances to their exposure to traumatism from the passage of boluses of food through the lower pharynx to the esophagus, or of cold drink. Several years ago I treated a case in which there was apparently a paralysis of the thyro-arytenoid muscles, with a paresis of the crico-thyroid and interarytenoid muscles on each side. Besides the elliptical opening in the glottis on adduction, the cords had the peculiar rounded outline described by Störck. This latter soon disappeared, but the laxness of the cords continued for some time. This condition supervened on the pharyngeal inflammation caused by swallowing carbolic acid. Besides in diphtheria, cases have been reported in, or as following, scarlatina, typhoid fever, influenza, measles, anemia, chlorosis, and psychical disturbances, cholera, trichiniasis, malaria, icterus, pneumonia, and poisoning from atropin, morphin,[1] arsenic, lead, and chronic alcoholism.

The very valuable recent paper by Heyman[2] comes too late to hand for a thorough analysis of the cases of toxic paralysis of the laryngeal muscles. His list of the poisonous agents includes lead, copper, antimony, phosphorus, arsenic, alcohol, atropin, morphin, and cocain.

In the same issue Lazarus reports paralysis of the abductors of the larynx in a case of gonorrhea in which no other morbid influence was evident. Occurring in connection with these affections, the situation of the lesion has usually been unknown; although from the symptoms in some it was referred to the bulb and the nerves, as well as to their peripheral distribution.

Some cases of laryngeal paralysis due to reflex causes in the nose and elsewhere have already been alluded to in this work, and others are to be found in literature.

Diagnosis and Symptoms.—Before confining ourselves strictly to laryngeal manifestations, something must be said in regard to the phenomena which accompany laryngeal paralyses due to lesions of the medulla and the vagus nerve.

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[1] Pneumonia and malaria (Schech) are included in the list of diseases, and atropin and morphin among the poisons which have caused laryngeal paralysis, but I can find no exact references to cases in the text-books of Sajous (p. 362, ed. 1889), Schech (*Die Krankheiten des Kehlkopfes*, etc., 1897), and Gerhardt.

[2] Fränkel's "*Archiv für Laryngol. und Rhinol.*," Band v., 1896.

In *lesions of the medulla oblongata* concomitant manifestations are almost always found elsewhere. The tongue may be paralyzed, atrophied, and protrude toward the affected side. There is usually a paralysis of the soft palate, causing nasal speech and the occasional regurgitation of food and drink into the nose. Difficulty in swallowing, from paresis of the pharyngeal muscles and anesthesia of the pharynx and larynx, may be present. There may be facial paralysis, deafness, and vertigo. Acceleration of the heart's action and of the respiration are of occasional occurrence. Sometimes the manifestations of bulbar disease are bilateral, in which case it is almost always the abductors alone which are affected; but usually, though not so frequently as in the other lesions, the laryngeal paralysis is unilateral. There is no well-authenticated case of paralysis of the adductors alone from any essential lesion. A few bulbar lesions have been reported by Jackson, Proust, Senator, and Eisenlohr as causing bilateral laryngeal paralyses.

Many of these bulbar cases die, especially those in which there is a double laryngeal paralysis, from the extent of the disease in this region which presides over the most vital functions of the organism.

Lesions of the Vagus Nerve.—The involvement of other nerves in bulbar disease establishes the diagnosis, as a rule; but occasionally lesions at the base of the skull may simulate it by involving the trunks of several nerves besides the vagus. Such are the cases reported by McBride, and by Schech, Bernhardt, and Nothnagel.[1] Baümler, Johnson, McCall Anderson, and Whipman have published cases in which pressure upon one vagus has caused laryngeal paralysis of both sides. This Johnson explains by stating that as the vagus contains centripetal fibers the ensuing degeneration extends to the medulla and there by decussation involves the motor area of the other side. Such seemed to be the explanation of a fatal case of double abductor paralysis reported by the writer[2] in 1892. Krause's contention that the recurrent laryngeal nerve contains centripetal fibers has not been sustained.

Paralysis of all the Muscles Supplied by the Recurrent Laryngeal Nerves.—The vocal cord assumes the "cadaveric position," a term first used by v. Ziemssen, and since then generally adopted to denote a position half-way between the median line (phonatory position, adduction) and the lateral wall of the larynx (deep inspiration or extreme abduction). When the paralysis is complete and bilateral the voice is entirely extinguished, and it is only by a great effort of expiration that the lax vocal cords are thrown into vibration and a hollow, whispering note is produced. Forcible respiration causes the arytenoid cartilages to tip inward at their summits, which produces a stridulous sound. When there is no crico-thyroid paralysis, or only partial paralysis of some of the muscles, these symptoms are variously modified.

Bilateral paralysis of the recurrents is occasionally caused by the involvement of both recurrent nerves in cases of thyroid or esophageal cancer or aortic aneurysms, as noted by Mackenzie and others.

Unilateral paralysis at first causes entire aphonia, but after a time the unaffected cord will be seen to make more or less extensive excursions across the median line to meet its fellow, with the result of producing a more audible whisper or even some rough phonatory sounds. There is no dyspnea either in bilateral or unilateral recurrent paralysis when complete; or when partial, except in cases of bilateral abductor paralysis. Bilateral recurrent paralysis may at first be mistaken for the functional paralysis of the adductors in hysteria, but a more careful examination will show that the cords do not move on forced inspiration; while in hysterical paralysis there are jerky movements of extreme abduction, or in some cases they may be immovable against the external laryngeal wall, leaving a much wider opening of the glottis than that left by the cadaveric position of the cords.

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[1] Histories quoted by Gottstein, page 390.

[2] *Loc. cit.*

Paralysis of the Abductors of the Larynx.—When *bilateral*, both posterior crico-arytenoid muscles being completely paralyzed, the patient without immediate help dies from suffocation. It seems to me exceedingly probable that many sudden deaths from cerebral apoplexy might be explained in this way. The stertorous breathing in apoplectic coma lends probability to this suggestion.

The cases, however, in which bilateral paralysis has been observed laryngoscopically, have been those principally in which the disability came on gradually in one or both cords. The vocal cords are seen almost in apposition throughout their length. There may be, however, a narrow elliptic slit between them; while at the posterior commissure an isosceles triangle is formed on inspiration. This is due to the relaxation or, when present on both inspiration and phonation, to the paralysis of the interarytenoideus muscle and the tensors of the vocal cords. Notwithstanding the great dyspnea in these cases, phonation is not materially interfered with, because the vocal cords are constantly in the phonatory position.

Treatment.—Tracheotomy in these cases is indicated to avoid impending suffocation. In my case and in others procrastination on the part of the patient resulted fatally. Where it becomes evident that the patient is liable to live a long time with a tracheotomy-tube, the question arises as to the excision of the vocal cords. This has been suggested by Hope and strongly condemned by Semon. It, of course, should only be done as secondary to tracheotomy, when it becomes evident that there is to be no recovery of function. The patient should have to choose between the extinction of voice and the necessity of wearing a tracheotomy-tube indefinitely. Judging from examples familiar to all laryngologists, we might expect some restoration of voice without vocal bands. So far as I know, this procedure has never been carried out in man, although adopted with advantage in horses as a cure for roaring. Division of one recurrent nerve has been done by Ruault in a case of bilateral abductor paralysis, in the hope that the cord would fall back to the cadaveric position; but this did not occur. Probably in all these cases, after a varying time, the adductors become atrophied from disuse as well as the abductors; but the arytenoid joint becomes stiffened also from disuse, and the cord is immovable.

Unilateral abductor paralysis is the most common of all the hypokinetic disturbances of the laryngeal muscles. When uncomplicated, it produces neither dyspnea nor dysphonia. It is not infrequently a surprising discovery in a routine laryngoscopic examination—giving, it may be, the first hint of a thoracic aneurysm, or possibly proving an unsolvable puzzle to the observer when he seeks its causation.

Paralysis of the Adductors of the Vocal Cords (*Crico-arytenoidei Laterales*).—Bilateral: This is the usual manifestation of hysteria in the larynx. It is distinguished by its sudden onset, as a rule, and by the fact that it occurs in a patient who nearly always presents some other sign of hysteria than the laryngeal one. Aphonia, occasionally the inability to whisper (apsithyria), the history of previous attacks which suddenly, from some trifling incident or from no assignable cause ceased, make the condition a tolerably easy one to recognize. Sometimes the patient is able to sing, but not to use a conversational tone; and various other phenomena which it is impossible to reconcile with the idea of an essential paralysis are helps in the diagnosis. Various theories have been advanced to account for the pathology of the affection. Thus Gerhardt supposes it to be of cerebral or nerve (vagus) origin because it is occasionally unilateral, and hence beyond the control of the will; but all theories to explain special phenomena in hysteria are of little value until an acceptable explanation with demonstrable material proof can be formulated to account for the general condition. The vocal cords are seen to be widely abducted, so that the glottis is constantly in the inspiratory position. Sometimes there seems to be a concomitant spasm of the abductors, so that the vocal cords disappear in the lateral larynx walls.

Paralysis of one lateral adductor has been noted by Mackenzie, Donaldson, Stewart, and others. Usually this rare affection is caused by hysteria or lead-poisoning. Some cases are recorded as due to reflex trouble in the nose. These cases have not been sufficiently studied to arrive at any conclusion in regard to differentiating between the functional cases (hysteria) and those probably due to some material lesion.

Paralysis of the arytenoideus, the transverse or central adductor, usually occurs in connection with that of the other muscles, but is sometimes noted as occurring alone, when laryngoscopic examination shows that the vocal cords are in apposition throughout their anterior three-fourths on phonation, with a triangular space posteriorly. Aphonia is more or less complete.

While these cases usually occur in connection with hysteria, a number of cases have been reported where they seemed to result from acute or chronic catarrhal affections of the larynx. Proust and Tissier's monograph has the bibliography to 1890. Few, if any, cases have been since reported.

Paralysis of the Tensors and Adjusters of the Vocal Cords (the external tensor—crico-thyroideus; the internal tensor—thyro-arytenoideus internus).—*Paralysis of the superior laryngeal nerve* supplying motor filaments to the crico-thyroid muscle and sensory filaments to the mucous membrane is a rare occurrence. Sometimes only the external or muscular branch seems involved, when it is said that the examining-finger will note the relaxation of the muscle by palpation of the crico-thyroid space. This has been caused by traumatism and operations, but more frequently results from diphtheria (v. Ziemssen). When resulting in total anesthesia of the larynx and of the epiglottis, great danger arises from the food and secretions entering the larynx. When this is accompanied by paralysis of the recurrent, the danger is still further increased. Mackenzie relates a case in which suppurative inflammation of the cervical glands caused paralysis, apparently of the superior laryngeal nerve alone; while Johnson reports a case following typhoid fever. According to the account given by Mackenzie, the vocal cords when adducted assumed at their line of junction a wavy appearance with a depression at the center. When only one cord is affected, it is seen at a lower level than the other side. Hoarseness and aphonia result.

Mackenzie, in his definition, says "Paralysis of the superior laryngeal nerve gives rise, when complete and bilateral, to anesthesia of the larynx and loss of power of the crico-thyroid, *thyro-epiglottic, and ary-epiglottic muscles.*" He further says, "When these muscles are paralyzed the closure of the larynx during deglutition does not take place, the glottis remaining erect and against the root of the tongue." This is incomprehensible, as these latter muscles, so far as I have been able to gather from authorities (Gray, Quain, Onodi), are intimately associated with the arytenoideus muscle and supplied by the recurrent nerve; and so far as I remember my own observations of laryngeal paralyses, I have seen this position of the epiglottis in connection

LEEDS & WEST-RIDING
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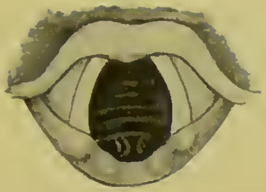
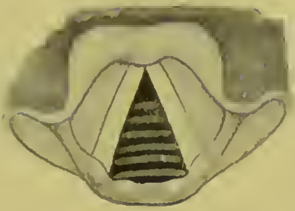
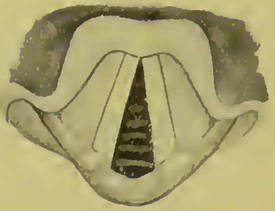
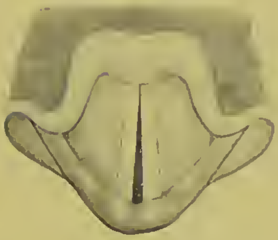
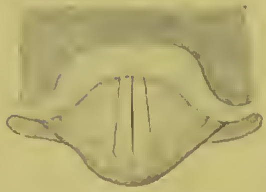
PLATE 15.

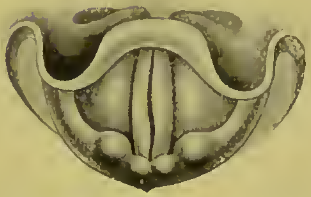

1. Forced inspiration.

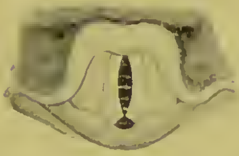

2. Quiet inspiration.

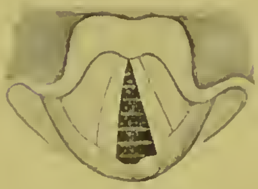

3. Relaxed or cadaveric position.

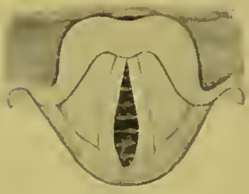

4. Moderate adduction.

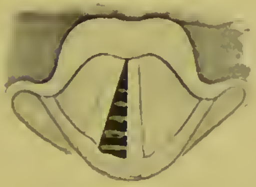

5. Phonatory apposition.

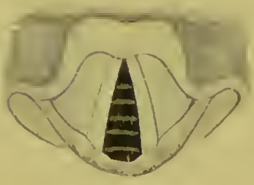

6. Bilateral paralysis of external tensors (Mackenzie).

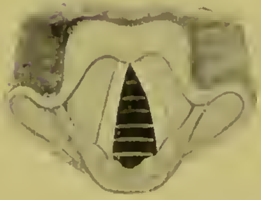

7. Bilateral paralysis of internal thyro-arytenoids and arytenoid.


8. Paralysis of left posterior crico-arytenoid. Inspiration.


9. Bilateral paralysis of lateral crico-arytenoids.


10. Left recurrent paralysis. Adduction.


11. Bilateral recurrent paralysis


12. Left recurrent paralysis. Abduction.

Semi-schematic illustrations of the glottis in health and in disease.

with paralysis of other muscles supplied by the recurrent. The passage of food into the larynx in connection with superior laryngeal paralyses, I should suppose to depend more upon the anesthesia than upon the loss of power in these muscles, as intimated by him. This is a point to which I have been unable to find any reference in other authors, and I hesitate to make the criticism of an almost faultless text-book.

Paralysis of the thyro-arytenoidei interni muscles alone occurs frequently as the result of strain and local inflammation. It is seldom complete. An elliptical opening of varying transverse diameter is seen on adduction. Hoarseness or complete aphonia results. Usually rest and local applications after a few days restore the function of the cords; although Mackenzie reports a case in which it was paralyzed for three years, and cured in three weeks by faradization.

While laryngeal paralyses have been treated *seriatim* and separately, it must be understood that in the peripheral manifestation various combinations may exist which alter and complicate the laryngoscopic image, due to the influences of synergistic or antagonistic muscles.

An error in diagnosis may frequently arise in mistaking for paralysis the ankylosis of a crico-thyroid joint due to inflammation, or the inability or limitation in a vocal cord due to infiltration of the muscles or stroma by tubercular, syphilitic, or cancerous disease, or to the existence of fibrous cicatricial bands.

Prognosis.—We have only to consider the prognosis as it relates to the recovery of power in paralyzed muscles. Loss of function due to essential lesions is rapidly followed in the small laryngeal muscles by fatty degeneration and atrophy. Complete laryngeal paralysis from these causes, when it has existed for several months, is rarely recovered from, as pointed out by Elsberg[1] many years ago. Aside, therefore, from irreparable changes in the nerve-trunks and centers, peripheral changes soon render a cure of essential paralysis unlikely.

Treatment.—Indications must be met, as they arise, to preserve the patient's life by tracheotomy or intubation. In pareses or partial paralyses, and in functional paralyses faradization by an intralaryngeal electrode may be of advantage. Prompt removal of causes, such as pressure on nerves or inflammatory processes, may restore action to immobile muscles when the trouble has not resulted in too much degenerative change. The same may be said of central syphilitic lesions.

HYSTERIA OF THE NOSE AND THROAT.

The manifestations of hysteria in the nose and throat, as elsewhere, are of such infinite variety and shade off so gradually into essential neuroses and so-called neurasthenia, that an orderly or complete account of them could not be given, if every case reported were reviewed and every case observed were reported.

Persistent or intermittent complaints of anosmia or parosmia are made by women in whose noses little can be observed that is abnormal. How to distinguish these cases from those in which there is essential disturbance of the olfactory apparatus is often a matter of great difficulty. When I see a neurotic woman with a nasal mucous membrane which is tolerably healthy, and yet who complains of anosmia persistently, so as to bring it to my especial notice, I always think it is a case of hysteria; because true anosmia is usually complained of incidentally by patients who come for relief of other nasal symptoms. Reference has already been made to cases who complain of subjective sensations of obstruction or irritation in the nose. Here again it is difficult to separate the elements which are neurotic if not hysterical. While typical cases of hysteria differ entirely from typical cases of neurasthenia, there are so many on the border line between the two that one frequently hesitates as to their classification exclusively in either category.

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[1] *Phila. Med. Times*, July 30, 1881.

Hysterical affections of the soft palate and pharynx are most frequently those of a sensory nature. Occasionally cases will be observed to simulate paralysis; but essential paralysis involves such a complex series of disturbances in deglutition, respiration, and speech, that flaws may be easily detected.

Hysterical aphonia has attracted more attention than any other manifestation of functional trouble in the larynx; yet we find simulation of almost every form of neurosis. Treupel[1] enumerates laryngeal spasm, nervous cough, inspiratory functional spasm of the glottis, phonatory functional spasm of the glottis, hysterical aphonia, and apsithyria, or hysterical mutism. All these have been mentioned in the preceding pages, and lack of space forbids any more extended notice of them. Local disease of trifling character in any part of the upper air-tract is frequently noted as a cause contributory to the general neurotic tendency. While it is usually observed in young women, it is by no means unknown in children or in people of advanced age, and is occasionally observed in men. Treupel's work deals exhaustively with the subject; and he asserts that all the laryngeal manifestations which have been observed in hysteria may, by practice in the healthy person, be reproduced at will. Of course, patients cannot be aware of the positions of the vocal cords taken in response to their impulses, but they can reproduce by their sensations states in which these phenomena occur. It is difficult, however, to explain all the laryngeal manifestations by this hypothesis. Laryngeal spasm persisting after loss of consciousness so that death ensues, is difficult to reconcile with the idea of exclusive control by the will.

Treatment.—Hysterical affections of the nose and throat can more frequently be cured by suggestion than by any other treatment. The methods of doing this are so various, and each one so often fails, that no one procedure can be considered of any exceptional value. Ostensible operations with forceps or cautery, or applications or mere examinations, accompanied by the confident statement of the operator as to its immediate efficiency, will frequently bring about a prompt disappearance of the local affection. These maneuvers will more frequently succeed in the unsophisticated patient on whom similar tricks have not been played before. Galvanism, that magical first cousin to charlatanry, is a potent device to bring about the desired impression on the patient. So far as my observation goes, all such phenomena are more frequently benefited, as to the local trouble, by individuals whose faith exceeds their scientific attainments, or whose effrontery supplants their scruples. However brilliant may be the immediate results of a deception, condoned by the ethics of Plato, it is only successful as concerning the immediate form of the neurosis, and does nothing for the general vice which lies behind, and is in no way a preventive of recurrence of the same trouble.

The treatment must be on the broad grounds of improving the general health and the moral tone of the individual, with an elimination of vicious influences—physical, social, and psychical.

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[1] *Die Bewegungens-Störungen im Kehlköpfe bei Hysterischen*, Jena, 1895; also *Berlin. Klin. Woch.*, No. 52, 1895. The former contains a very full bibliography of laryngeal hysteria.

THE VOICE—ITS PRODUCTION AND HYGIENE.

BY G. HUDSON MAKUEN, M. D.,

OF PHILADELPHIA, PA.

VOICE may be defined as a moving column of breath set in vibration by its own impact with the vocal bands and reinforced by its diffusion through the various resonators into the surrounding atmosphere. According to this definition there are three important elements to be considered in relation to voice—namely, the moving column of breath, the vocal bands, and the resonators. We shall consider these elements in their order.

The Moving Column of Breath.—This column may be regarded as having the diaphragm for its base, and as being set in motion by the respiratory muscles. This motor process has been called the breathing of voice-production, and it differs from ordinary so-called natural breathing in that the one is active and voluntary, while the other is passive and automatic. Ordinary breathing is simply for the purpose of aërating the blood. The breathing of voice-production performs this function only incidentally, its main purpose being something far more complicated and difficult of execution. The large thoracic and abdominal muscles, some of them among the strongest in the body, must be controlled with precision and accuracy. They work to a great extent in pairs, and of these pairs the one muscle opposes the other. For instance, the contraction of the diaphragm results in a protrusion of the abdominal walls (Fig. 664), and the strength of this protrusion depends upon the force of the contraction, which may be made very great. This outward motion of the abdominal walls is checked by the contraction of the abdominal muscles, which oppose in their action that of the diaphragm. In a similar way the costal muscles oppose each other, one set tending to elevate the ribs and the other to depress them. Thus the vocalist utilizes in breathing the principle of opposition of forces, by means of which perfect equilibrium of the various organs is maintained, and great strength becomes compatible with great delicacy of action.

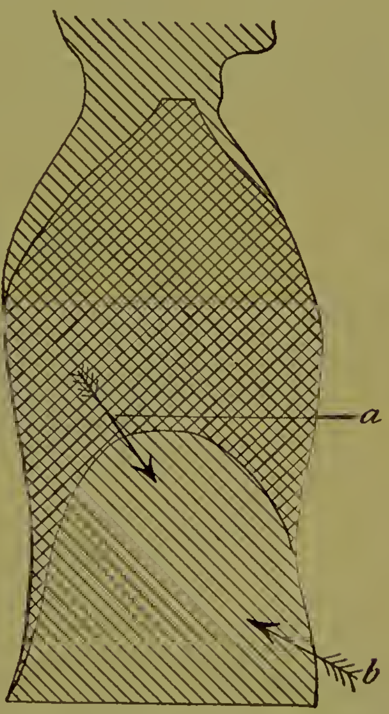

FIG. 664.—Schematic representation of the moving column of breath and the opposed action of the diaphragm (*a*) to the abdominal muscles (*b*).

Very little breath is required for the production of tone, and the function of the respiratory muscles is not so much to force breath out of the lungs, as to sustain and control the breath in the lungs and to give to the thorax a certain drum-like tension which is very essential to a resonant and well-balanced voice. Just as the drummer tightens his drum-strings, so the vocalist contracts his thoracic and abdominal muscles. This may be best explained, perhaps, by describing the muscular action in the production of a single prolonged tone. There are two distinct processes: first, that of preparation, and second, that of actual tone-making. The preparatory process is similar to that which naturally takes place just prior to any other muscular act, as, lifting a weight or striking a blow. There is a slight inspiratory movement caused by the contraction of those muscles the function of which is to elevate the ribs. The diaphragm should have no part in this action, for its contraction depresses the ribs, and therefore it must be considered as an expiratory muscle. The second process, or that of production of tone, now follows, and consists, not, as many would have us suppose, in a complete relaxation of these inspiratory muscles, allowing the ribs to fall to their original position, but in a continuation of this tension and a simultaneous and stronger contraction of the expiratory muscles. The strength of this latter contraction should be proportionate to the strength of the desired tone and to the amount of breath which it requires.

Thus we have to deal with two distinct sets of muscles; one, the inspiratory, tending to elevate the ribs, and the other, the expiratory, tending to depress them. It is the nice adjustment of these opposing forces that gives to the thorax that degree of tension upon which the accuracy of breath-control and the consequent equilibrium and smoothness of the voice so much depend; and it is the education of these muscles which constitutes the first step in the cultivation of either the speaking or the singing voice. So far as possible, each muscle must be brought under perfect control and trained to respond promptly and accurately to an intelligent volition.

The Vocal Bands (Fig. 665).—These bands correspond to the strings of the violin. They are composed of small elastic threads of yellow fibrous tissue, and are from one-half to three-quarters of an inch in length, longer in the male than in the female, and situated in the larynx, or voice-box, so called because it encloses and protects these essential organs of voice (Fig. 542). The framework of this box is composed of cartilage, a material more flexible than bone, yet more rigid than muscular or ligamentous tissue. These cartilages, nine in number—the thyroid, the cricoid, the two arytenoids, the two cornicula larynges, the two cuneiform cartilages, and the epiglottis—articulate with one another by means of freely movable joints, and they are held together by numerous ligaments and controlled by still more numerous muscles. It is the motion imparted to the cartilages by these muscles which serves not only to place the vocal bands in the phonating position, but also to give them the necessary degree of length, weight, and tension. The arytenoid cartilages, to which the vocal bands are attached posteriorly, are freely movable at their points of articulation with the cricoid cartilage, and they are made to rock and revolve upon these points (Fig. 666) by means of various sets of muscles. The same principle of opposing forces applies here as in the management of the muscles controlling the column of breath. The contraction of one set of muscles tends to revolve

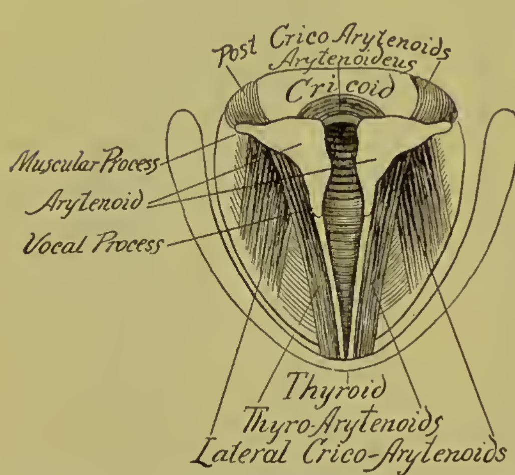

FIG. 665.—Diagram of the larynx, showing the vocal cords in relation to the arytenoids and the adductor, abductor, and tensor muscles.

the cartilages in an inward direction, thus approximating the vocal bands; and the contraction of the opposing set tends to revolve them in an outward direction, retracting the bands and opening the glottis.

The *lateral crico-arytenoids* and the *arytenoid* combine in their action to close the glottis, and their opposing muscles, the posterior crico-arytenoids, tend to dilate the glottis; and it is by the nice adjustment of these forces that the vocal bands may be made to assume any position from that of close apposition to the sides of the larynx to that of close approximation in the median line, or even partial overlapping of the posterior edges, thus shortening the vibrating surface. When the vocal bands thus approach approximation, with only a narrow chink between the thin edges, their degree of tension is determined in the following manner: The thyroid cartilage, to which the vocal bands are attached anteriorly, is freely movable at its points of articulation with the cricoid, and its tilting forward upon the cricoid tends to remove it farther from the arytenoids (Fig. 666), and thus to make tense the vocal bands and also to elongate and attenuate them (Fig. 564). The forward tilting of the thyroid cartilage is accomplished in part by the *crico-thyroid muscle,* but chiefly by a muscle extrinsic to the larynx, the *sterno-thyroid.* The muscles opposing this downward and forward movement of the thyroid cartilage are the *thyro-hyoid* and *thyro-arytenoid* (intrinsic muscles) and the *stylo-hyoid* and *digastric* (extrinsic muscles). The importance of these extrinsic muscles of the larynx is not generally understood. In addition to controlling the degree of tension of the vocal bands, they serve to fix the larynx firmly against the cervical vertebræ during the emission of strong resonant tones.

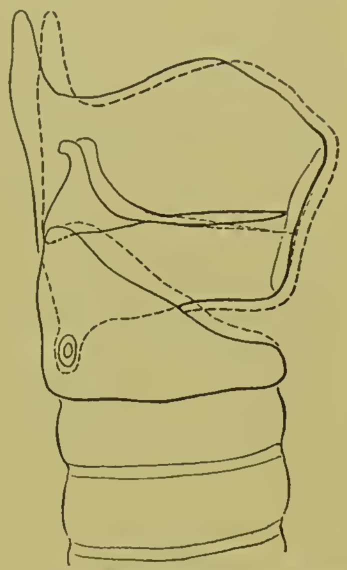
FIG. 666.—Diagram of the thyroid cartilage tilting upon the cricoid and stretching the vocal cords.

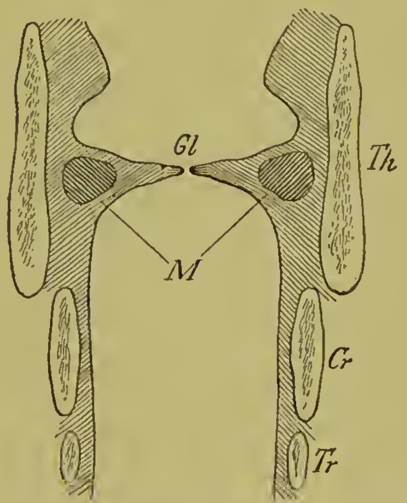

FIG. 667.—Section of the larynx at right angles to the vocal bands: *Gl,* glottis; *Th,* thyroid; *M,* thyro-arytenoid (Muckey).

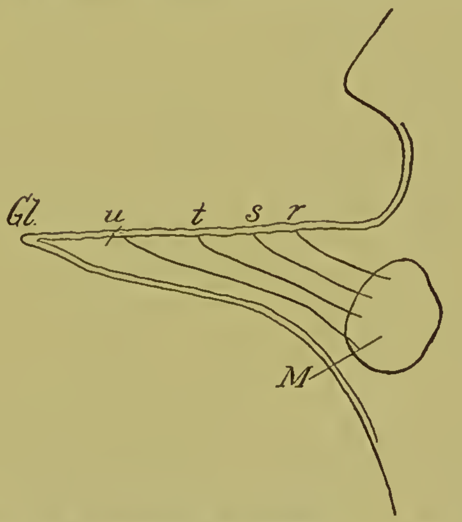

FIG. 668.—Schematic representation of the vocal band, showing the thyro-arytenoid muscle and "how it sends its fibers into the body of the band" (Muckey). When this muscle is but slightly contracted the band may vibrate as far back as *r;* but when it is more and more contracted the extent of vibration is limited first to the point *s,* then to *t,* until finally, for the highest notes, only the part between *u* and the edge *Gl* is allowed to vibrate.

The *thyro-arytenoid* muscles also serve, by means of their intimate relation with the vocal bands, to limit the amount of their lateral vibrating surface and to adjust the lips of the glottis (Figs. 667, 668).

In the untutored larynx and throat these muscles are practically involuntary, and may perform their function very imperfectly; but in the process of the cultivation of the voice many of them may be brought under control of the will and thus trained to perform their function with greater efficiency. A laryngoscopic image of the larynx shows the vocal bands to be slightly separated posteriorly during ordinary breathing, and widely separated and flattened out against the sides of the larynx during deep breathing (Fig. 541). The extent of the separation depends upon the action of the abductor muscles, which turn the arytenoids outward. When the adductor muscles—those which turn the arytenoid cartilages inward—contract and the abductors relax, the bands come together in the median line and shut off all communication between the trachea and the pharynx. This always takes place immediately before the act of coughing or clearing the throat. But when the abductor muscles contract in conjunction with the adductors, the arytenoids become nicely poised upon their pivots, turning one way or the other by a minute fraction of an inch, as the vocal bands are required to be separated or approximated. It has been estimated that as slight a change as one-seventeen-thousandth of an inch is necessary to produce the wonderfully minute variations in pitch of which some of our noted singers are capable.

The Resonators.—Strictly speaking, the whole body is a resonator of the voice; and not only so, but the platform upon which the speaker or the singer stands, and the house in which that platform is built, are all in a certain sense resonators of the voice. The chief resonators, however, and those which contribute most to the individual characteristics of the voice and to its reinforcement, are the thorax, the trachea, the larynx, the pharynx, and the oral and nasal cavities with their contiguous structures.

The thorax, although not always so regarded, is one of the important resonant organs. The column of breath, resting as we have shown upon the diaphragm, receives vibrations from the vocal bands in the same way that the air above the bands receives vibrations; and when the ribs are slightly elevated and the muscles taut, the thorax becomes tensioned like a drum, and adds to the voice a peculiarly characteristic and pleasing quality.

The trachea is also an important resonator, and it is so constructed that the trained vocalist can increase or diminish its size both longitudinally and transversely, thus making it equivalent to a series of organ-pipes. It is for this reason, and because of the bellows-like function of the lungs, that the vocal mechanism is said to resemble that of the pipe-organ (see page 843).

The larynx itself probably has more to do with determining the quality of voice than any other part of the mechanism. Its size varies greatly in different individuals, and this variation is the chief cause of the wide differences in the qualities of voices. One illustration of this fact may be found in the marked change which takes place in the male voice at puberty. With the increase in size and density of the various parts of the larynx we have a sudden change in the quality of voice. The thin, childish treble grows into the heavy baritone or bass; and the transition stage is an important one, and should be treated with great care. Many a voice is injured irreparably by overwork at this period. Another illustration of the manner in which the size of the larynx determines the quality of voice is found in comparing the male and female larynges and voices. In almost exact proportion as the female voice is lighter and more flexible than the male voice, will the various parts of the female larynx be found to be lighter and more flexible than those of the male larynx. Of course, the differences in the other resonators contribute somewhat to these distinguishing characteristics, but the chief cause exists in the laryngeal variations. The ventricles of the larynx—two depressions immediately above the vocal bands and parallel with them—and the ventricular bands situated immediately above the ventricles, influence the voice mainly by governing and directing the stream of vocalized breath after it leaves the glottis. The ventricles unite to form a little vestibule, the entrance to which is the chink of the glottis, or the space between the lips or edges of the vocal bands; and the exit is the space bounded by the corresponding thicker edges of the ventricular bands. During its entrance into the vestibule the breath is set in vibration or vocalized; this vocalized breath transmits its vibrations to the air already in the vestibule; and these vibrations are directed out through the ventricular exit into the upper larynx, the pharynx, and the mouth. The position of the larynx also has much influence on the voice. If it be held firmly fixed against the spine by the extrinsic muscles, the vocal resonance will be greatly increased. The entire spinal column may thus become a resonator of the voice.

We now come to a consideration of the pharynx as a vocal resonator. It is a funnel-shaped muscular bag with seven openings, and, like the mouth, it forms an important part of the alimentary canal, with the opening into the esophagus at its lower and posterior portion. The size and shape of the pharynx, however, and its general physical condition are important elements in the formation of voice. The posterior wall of the pharynx, a portion of which may be seen by direct inspection through the mouth, is well adapted in its construction to gather the sound-waves as they are reflected from the epiglottis, and project them forward beneath the soft palate against the firm sounding-board formed by the hard palate and the teeth. Covering the solid, bony framework of the posterior wall of the pharynx we have the constrictor and palatopharyngeal muscles, which by their numerous contractions serve so to shape the reflecting surface that the vocalized breath may be directed toward any desired point. The training of these pharyngeal muscles forms a very important part of the work of the vocal teacher; and the care of the mucous membrane in this region is of the utmost importance to the voice. Inflammatory adhesions and thickenings act in various ways to injure the voice. They encroach upon the size of the pharyngeal space, they interfere with the free action of the muscles which have been mentioned, and they transmit to the larynx and trachea their deleterious influence both by force of gravity and by continuity of structure. That the condition of the pharyngeal vault is an important factor in the resonance of the voice is shown by the marked change which takes place in the character of tone whenever this space is encroached upon by glandular or other hypertrophy. Adenoid vegetations, for instance, on account of their peculiar moist and spongy consistency, serve to damp the voice and destroy

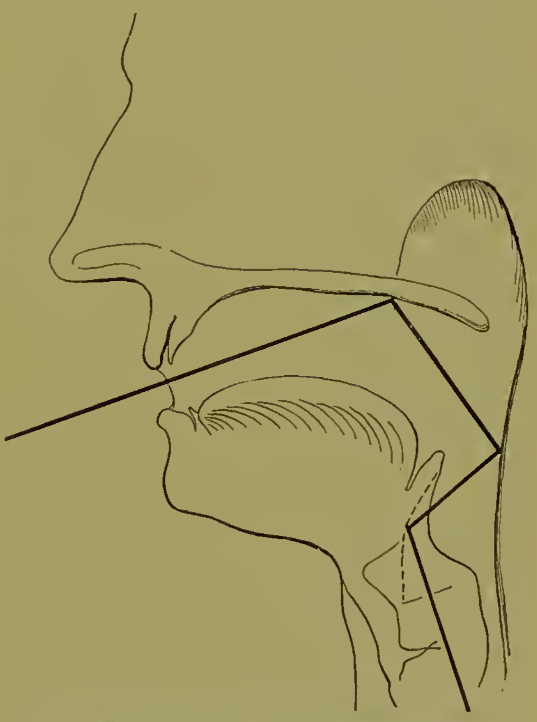

FIG. 669.—Diagram of the course of sound-waves reflected from the epiglottis to the pharynx-wall, up to the palate, and thence out of the mouth.

the resonance that comes from this region. The posterior pharyngeal wall (Fig. 670) ascends vertically to a point about on a level with the floor of the nose, and then gradually inclines forward, making a graceful curve over to a point just above the choanæ. The shape of this portion of the pharynx has been imitated in nearly all the artificial sounding-boards, whether constructed for the reflection of the voice or of the sounds of other musical instruments.

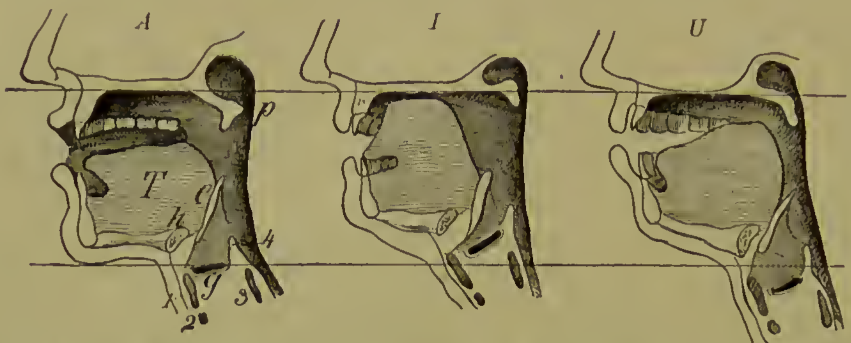

Fig. 670.—Section of the parts concerned in phonation, and the changes in their relations in sounding the vowels *A* (*ah*), *I* (*ee*), *U* (*oo*) (after Landois and Stirling); *T*, tongue; *p*, palate; *c*, epiglottis; *g*, glottis; *h*, hyoid bone; 1, thyroid; 2, 3, cricoid; 4, arytenoid cartilage.

It is the function of the soft palate and the uvula to act as a kind of valve controlling the sound-waves and directing them either up through the pharyngeal vault into the nostrils when the palato-glossi muscles contract and diminish the size of the fauces, or out through the fauces into the mouth when the palato-pharyngei muscles contract and draw the palate back toward the pharyngeal wall, diminishing or cutting off entirely the passage-way to the post-nasal space. These to-and-fro and up-and-down movements of the soft palate during articulation are well demonstrated by a very ingenious instrument devised by the late Dr. Harrison Allen. It consists of a moderately stiff wire passed along the floor of the nostril until the distal end, which is slightly curved downward, rests upon the soft palate. The proximal end is placed against a revolving cylinder, and upon its prepared surface the up-and-down movements of the palate are accurately traced. This device furnishes a valuable aid to the study of an important part of the oral mechanism. The nasal chambers themselves and their communicating cavernous bones contribute much to the agreeable quality of the speaking voice, the nasal element being essential to the fullest and richest tones. For the sustained tones of the singing voice the palatal and pharyngeal muscles are tense, and the soft palate is held fixed against the pharyngeal wall, the sound-waves being directed entirely through the mouth. This tense condition of the palate is necessary in order that the palato-pharyngei and other extrinsic muscles of the larynx may perform their function. It is these variations in the size and shape of the vocal organs which determine the character or timbre of tone and distinguish one voice from another. There are no two voices alike, any more than there are two faces or two leaves on the trees alike. People are recognized by their voices as they are by their faces, and there are certain distinguishing characteristics in both which may not be changed. Not all voices may become great voices any more than all faces may become beautiful ones; but all voices may be improved by training, as all faces may be improved by care and cultivation.

Many of these resonators of the voice, such as the lips, the teeth, the tongue, the soft palate, the pharynx, and even the upper part of the larynx, may be regarded as belonging to an entirely different mechanism—viz., that of articulation. We have considered the voice-producing organs; these are the speech-producing organs. The organs of voice manufacture the sound, and the organs of speech articulate it. The mechanism of articulation is as important as that of phonation to the singer as well as to the speaker; and these two mechanisms must work together in perfect harmony if we would have good speech and good song. The articulation of the singing voice differs in no respect from that of the speaking voice. It consists simply in the moulding of sounds into syllables and words which mean something to the ear, whether they be the sounds of speech or of song.

The palate is probably the most important organ of articulation. Fairly intelligible speech has been shown to be possible without a tongue, but the lips and teeth could more easily be dispensed with. Furthermore, the larynx and lungs are not absolutely indispensable to the production of tone, as has been proved by at least one person who can speak and even sing without any larynx and with the lungs entirely cut off from the pharyngeal and oral cavities. Not all persons, however, would learn to speak without a tongue or without a larynx. Indeed, most people speak badly enough who are not thus handicapped; and it is interesting to notice how slight a deviation from the normal in some of these organs will result in the most glaring defects of speech. All irregularities of the vocal and speech organs, whether acquired or congenital, should be corrected as early in life as possible, before the habits of speech are fully formed.

The Hygiene of the Voice.—The hygiene of the voice includes the hygiene of the whole physical organism, for there is scarcely any portion of the body which is not related directly or indirectly to the mechanism of the voice. Disease of any kind is reflected in the voice as clearly and as undeniably as in the face, and the cheerful ringing tones of exuberant health are known to us all. Therefore, whatever contributes to the well-being of the physical organism contributes also to the well-being of the voice.

It is a mooted question among specialists whether catarrh of the stomach is the cause of catarrh of the upper respiratory and vocal passages, or whether catarrh of these passages is the cause of catarrh of the stomach. This much we know, that the pharyngeal and oral cavities are continuations upward of the alimentary canal, and are lined with the same membrane; that the color and general condition of the tongue are clear indications of the condition of the stomach below. A coated tongue means a coated stomach, and, if I may use the expression, a coated voice. The care of the digestion, then, is of the first importance to the vocalist, both because of its direct influence upon the organs of voice and because of its indirect influence through the circulatory and nervous systems. Strong healthy nerves are essential to a good voice, and these nerves are dependent upon good blood properly circulating; and this, in turn, is dependent upon good digestion, and this upon good food thoroughly masticated. Articles of food affect the voice also by direct contact with the organs, and therefore highly-seasoned and stimulating food should be avoided. Tea, coffee, liquors, and the after-dinner cigar may injure the voice in the same way, and can be beneficial only when they offset these deleterious effects by assisting in the digestion of nourishing foods. No absolute rule can be laid down regulating the diet of individuals, for what is food for one is poison for another. Someone has well said that every man over forty years of age should be his own physician as far as diet is concerned, and I would place the age limit ten years earlier. The man who cares more for his stomach than for his voice will never make a great singer or a great speaker. The vocalist must eat to live, and not live only to eat;

and no little self-denial, in this and in other respects, is the price which must be paid for a well-preserved voice.

Madame Patti has said that a draught of air has always been the dread of her life. The cutaneous surface of the body should be classed among the organs of respiration. Indeed, it has been called the "outer lungs," on account of its absorbing and eliminating capacity. The skin should be kept active, therefore, by suitable exercise and judicious bathing. General exercise should never be carried to the point of fatigue, lest it result in the needless expenditure of that vital energy which is so necessary to the working of the vocal mechanism, and in the abnormal development of certain muscles, which prevents that harmonious action and nice adjustment and co-ordination so essential in the management of the vocal machinery. The matter of bathing should also receive careful attention. Many people bathe too much, and many more bathe too little. It should be remembered that the hot bath extracts heat from the body, and heat is only another word for energy. Only the very vigorous should take frequent hot baths, and they should be taken only upon retiring. The cool, daily plunge may be indulged in to advantage by many; but perhaps the cold hand- or sponge-bath, both morning and evening, is better for the average person. The feet, the upper chest, the neck, and the face should be hardened by frequent cold douches. These parts are the vulnerable ones in the singer and speaker.

As to the matter of dress, I am inclined to think that the less dress the better. As some one has said, "Man is not by nature a clothed animal." Whole races have been swept from the face of the earth, with not one left to tell the tale, because they were compelled by their conquerors to wear clothes. Heavy winter flannels, which may not be changed to suit the conditions of the moment, are positively contraindicated because they interfere with the breathing of the outer lungs. In other words, they interfere with the natural functions of the skin, throwing its work upon the mucous membrane or "inner skin," as it has been called. The natural result of this overwork of the mucous membrane is congestion, with all its deleterious effects upon the voice. We say we have "taken cold;" but "cold" does not express it any more than would "heat" or "indigestion," for either is probably a more frequent cause of the condition.

Voice-training.—This brings us to the training of the voice, which is, after all, the most practical part of our subject. "There are methods and methods," as some one has said, "and there is good in every one of them, but no one of them has a monopoly of the good."

Methods have their origin in the necessities of certain cases. We are too apt to reason in this way: My method eradicated my faults in vocalization and developed my voice to its present magnificent proportion; therefore it will eradicate your faults and develop your voice,—forgetting that no two of us are exactly alike, and that my faults are not necessarily your faults, nor is my voice your voice.

I do not believe, therefore, in so-called methods for the training of the voice, any more than I believe in iron-clad rules for the treatment of disease. Quinin is a good thing for malaria, but not every case of malaria may take quinin. The vocal teacher should use methods just as the skilled physician uses remedies. He should study the necessities of the case, he should make a thorough diagnosis, if you please, of the conditions as they exist, and then decide upon his plan of procedure, thus putting vocal training upon a scientific basis. This necessitates a thorough knowledge of the organs involved, and of their functions, both natural and special. The physical training of the voice, reduced to its final essence, consists in the development and specializing of certain definite muscles. This, of course, can be carried to its highest perfection only when there is a corresponding psychical development. The one stimulates the other, and it is a question which takes precedence in the evolution of the singer or speaker. Written rules for the training of the voice are impracticable—one must have the living teacher, the choice of whom should be made with great care, for more harm than good is often done by bad teaching.

The ear is also an important factor in the training of the voice. It must be taught to stand guard over every tone, to become a fair and unprejudiced critic, exacting to the last degree. Defective hearing, therefore, is one of the greatest obstacles to vocal development. The man who cannot see his faults will rarely, if ever, eradicate them; and every man must perceive his vocal imperfections through the medium of the ear. Therefore the greatest care should be taken to preserve the functions of this organ. Acute inflammations of the ear should be promptly attended to by the skilled aurist; and at the first intimation of uneasiness in the ear, or beginning deafness, professional advice should be sought—for then, if ever, can the hearing be saved. An ounce of prevention at this time is worth a ton of cure later on. The cause of deafness is often traced to some catarrhal trouble in the nose or throat; and, fortunately, the vocalist generally discovers this trouble before the ear becomes seriously affected.

OPERATIONS UPON THE AIR-PASSAGES.

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DEFORMITIES AND DEFECTS OF THE NOSE.

Nasal deformities are generally divided into idiopathic or congenital and traumatic or acquired. The former are usually regarded as mere accentuations of certain racial types; but no special deformity can be said to be governed merely by racial influences. Congenitally-deformed noses may, however, vary from a mere rudimentary knob to a very large and greatly distorted organ. Traumatic or acquired deformities sustain little or no relation to the natural conformation of the nose, and therefore may assume any form in which accident or disease happens to leave them.

From a surgical point of view, nasal deformities are to be divided into those in which the normal parts are present, but distorted from their natural position, and those in which there is a partial or complete absence of these parts. The first comprise those which affect the bony portion of the nose and those which affect the cartilaginous and soft parts.

Deformities of the bony portion may be subdivided into the *vertical*, in which the dorsal profile is distorted, being too convex or too concave, and the *lateral*, which, when viewed from the front, present abnormal contour, whereby the bony portion may be either spatulated or deflected. Deformities of the cartilaginous portion include excess or deficiency in the tissue of the *tip* of the nose, or its distortion from normal direction, and collapse or abnormal expansion of the *wings* of the nose.

TREATMENT.

The treatment of nasal deformities differs in those in which the normal parts are present, but distorted from their natural position, and those in which there is a partial or complete absence of these parts.

In the former, treatment consists merely in restoring the parts to their normal position; whereas in the second class the deficiency must be supplied by tissues taken from some other part of the body, or by artificial or mechanical supports. In all cases, however, after securing or maintaining full respiratory patulency, the main cosmetic indication is to restore the symmetry of the nose. A nose which was originally proportionate to the face will, if deformed, appear very unsightly; while the same nose, although made one or two sizes smaller, will have a more or less handsome appearance if its different parts are perfectly symmetrical. So symmetry, and not size, is to be considered.

In the correction of deformities of mere displacement all operations should be done subcutaneously and without wounding the skin, in order to avoid scars which might be as unsightly as the original deformity. In some instances fracturing of the nasal bones and of the septum also may be necessary in order to restore the parts to their normal position.

In all intranasal operations full asepsis of the instruments and hands is essential, and of the nasal vestibules, where the vibrissæ form a natural sieve to strain out all foreign matter from the inspired air. Mild antiseptic spraying and mopping of the accessible portions of the nasal chambers and nasopharynx should follow, and may be repeated after operation if clearly demanded; but rather better nasal results, with far less danger to the ear, have followed the abandonment of too much after-spraying and syringing.

The Convex Vertical Deformity of the Bony Portion of the Nose.—In correcting this deformity the skin is first raised from the deformed or projecting portion by incising within the nostril through to the under side of the skin. The opening is then enlarged sufficiently to admit the instrument required for the removing of the redundant tissue, which may be bone-scissors, rongeur forceps, a slender saw, or a chisel, according to the nature of the tissue to be removed. Care must be exercised not to remove too much of the redundant tissue, lest a depression more unsightly than the original deformity be left in the top of the nose. This accident more readily happens when the vault of the nasal passage extends all the way up into the projection, for the nasal chamber is very easily opened into on removing the projecting angular portion. After this redundant tissue has been removed, a gentle compress should be placed over the dorsum so as to maintain the integument coaptated against the nose, and worn from four to six days or until the skin has united to the tissue beneath.

Concave Vertical and Spatulated Deformity.—The operation consists in filling in the depressed and lowering the unduly prominent portions. As the depressed or saddle-back deformity, as it is termed, is usually the result of injury causing displacement of the tissues, it is not often that the nose can be made as large as it originally was; but it can be made symmetrical by filling in the low places with tissues taken from the elevated portions. This is done by raising the skin from the dorsum by incising from the inside of the nostril, as before, and, if the nose is flattened out, removing to the top of the nose the displaced tissue found at the sides, by making flaps and turning them upward. Bony ridges or projections are in this manner to be used by carefully sawing them off with a sharp slender saw. If the displacement of the tissue is into the nares, it can be utilized in the same manner by turning the flaps made from it up under the skin upon the dorsum of the nose.

When it is necessary to refracture and raise the depressed nasal bones, this is done according to a method which I have devised—by an incision, as before, sufficiently large to admit one blade of a pair of stout forceps, which is slipped under the skin raised from the nasal bone; while the other blade, covered with a rubber hood or adhesive plaster to avoid lacerating the mucous membrane, remains in the nasal passage. Sufficient force is then exercised to fracture the bone, assisted by slightly rotating or twisting the blades, when it can be raised to the desired position. The bone on the opposite side is then, if necessary, fractured in the same manner, and they are held in the desired position by an internal support, as described in the Treatment of Fractures of the Nose (page 1122). If the end of the nose still projects above the line of the central portion, it can be lowered, as later described.

Many plans for the making of a new nose, as will be presently described, have been used for correcting these minor defects. There is no advantage in nor necessity for performing external operations when we can work subcutaneously to avoid wounding the skin and also utilize the normal tissues instead of resorting to mechanical supports for the correction of these deformities.

Deflection of the Bones of the Nose.—In correcting this deformity it is usually necessary to fracture the nasal bones, and on one side force the bone outward, on the other side inward. It may be also necessary to fracture the nasal septum, more or less, and to overcome the distortion of the cartilaginous portion. After fracturing the bones they should be held in the desired position, as in the treatment of fracture of the nasal bones. Great care must be exercised in the performance of these operations, and they are only to be undertaken under the most favorable conditions (see page 1119).

Excessive or Deficient Development of the End of the Nose.—The operation for *excess* (commonly termed pug-nose) consists in turning back the mucous membrane and, from the interior of the nostril, removing enough of the redundant tissue at the end to make the nose symmetrical and to bring the end down on a line with the dorsum. The mucous membrane is then replaced and supported by a light antiseptic compress in the interior of the nostril. Any associated expanded condition of the wings should be dealt with as will presently be described. After the operation the nose is to be held in the desired shape by the metallic form (Fig. 641), applied to the outside of the nose for several days, until healing in the exact position has taken place.

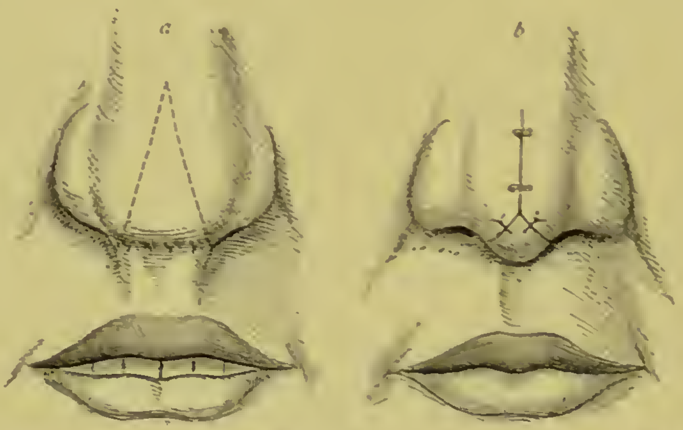

Fig. 671.—Operation for lengthening and narrowing the tip of the nose (Linhart).

Deficiency of the tip is corrected by raising the skin and filling in the defect by means of plastic operation according to the conditions found. Where the frenum is short or defective, this can be rectified by taking flaps from the floor of the nose or upper lip. The upper portion of the tip can be filled in with tissue taken subcutaneously, in the form of flaps, from the sides of the nose and cheeks (see also Fig. 671).

Often a flattened condition of the end of the nose is associated with a lateral expansion of the alæ, and is relieved by correcting the latter condition.

Deviation of the Tip of the Nose from the Median Line.—As this deformity is almost always associated with deviation, distortion, or dislocation of the triangular cartilage of the septum, it is usually necessary to straighten the septum, and in some cases this will be found to be all that is required to correct the deviation of the end of the nose.

This operation is performed by loosening the cartilage, and sometimes the columna also, along its junction with the superior maxillæ, and making a vertical incision through the cartilage at the bend or point of deflection. The cartilage is then placed in position and held there with transfixion-pins or splints or hollow plugs placed in one or both nostrils. Sometimes incisions are necessary to overcome the elasticity of the cartilage at other points. In most cases this is best done with a bistoury. With a finger in one nasal chamber we can determine when the cartilage has been completely incised from the other side without cutting through the mucous membrane beyond. By leaving the membrane intact on one side, it serves as an excellent splint to maintain the edges coaptated while healing. In some cases the end of the nose may appear to be deviated by reason of an excessive development or expansion of the shield cartilage on one side alone, the other side being straight and normal. Sometimes, when the lateral shield cartilages are deformed or distorted to one side, it is also necessary to freely incise them from the inside or loosen their attachment in order to overcome such elasticity as may tend to reproduce the deformity. The nose should then be held in place with a splint on the inside (Fig. 644) or a form on the outside, or sometimes by both, until it becomes fully fixed in the desired shape and position.

It is not infrequently the case that distortion of the end of the nose is associated with a deviation of the whole nose, in which cases it is necessary to combine the operations for correcting the deviation of both the osseous and cartilaginous portions of the nose.

Collapse or Expansion of the Alæ.—Correction of the deformities of the wings, whether collapsed or expanded, consists in carefully incising in several places from the inside the lower lateral and sometimes also the upper lateral or shield cartilages (see Fig. 645). It may be necessary in some cases of greatly expanded or inflated alæ to excise a V-shaped portion of the cartilage to permit of its being moulded to the desired shape. The parts are then to be placed in position by first inserting into the nostrils an internal support of the desired size and shape, consisting of a short tube of suitable material, and should be held there by an external shield until firmly fixed.

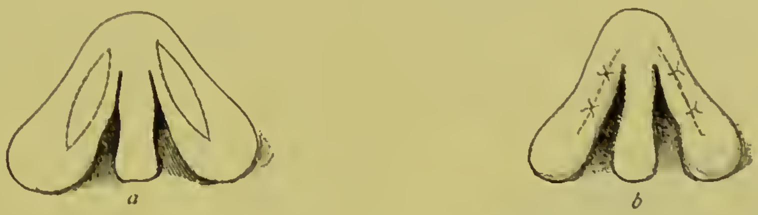

FIG. 672.—Operation for reducing redundant tissue of the alæ (Linhart).

In case of expanded nostrils it will generally be necessary after the operation to apply only the external support or compress to maintain the parts in the desired position until the tissues become more fixed; whereas in the collapsed condition of the wings the external support is rarely necessary, the nostrils requiring simply to be expanded to their normal size and shape, and maintained in this position until the tendency to collapse is overcome.

Should the expansion of the alæ, however, be due to distention from an intranasal growth or foreign substance, the necessity for the removal of the growth or body is self-evident before the deformity of the nostrils can be overcome, and further intervention may be unnecessary (see also Fig. 672).

Stenosis of the Nostril.—The nostril or the vestibule of the nose may be so small upon one or both sides as greatly to impede proper respiration. This may be a congenital smallness or deficient development or an acquired lesion due to cicatrization after burns, lupus, or syphilitic ulceration. Acute inflammation of furuncular or other nature may temporarily close the nostril, but this would call only for evacuation of pus or similar obvious intervention. For the simple stenosis, dilatation by frequently forcing in the lubricated finger may be sufficient, or the wearing of a tube for a time may be required. When the constriction cannot be thus easily overcome, divulsion may be necessary, care being taken to maintain the passage well dilated until after the parts have healed. Where loss of substance precludes success by these simple methods, plastic operation by flaps or skin-grafts will supply the deficiency.

The cutting away of a stenosis where the mucous membrane is already too limited in extent should not be attempted, for the reason that the surface will invariably grow together throughout the extent of the incision. In these cases it is best to raise the skin or mucous membrane from the contracted portion and remove the cicatricial connective tissue from beneath, then replace the parts and dilate the nostril to its fullest extent until healed, when they will remain in place, leaving the opening of the vestibule free.

PARTIAL OR COMPLETE ABSENCE OF THE NOSE.

There are two principal methods by which defects and deficiencies of the nose may be supplied or corrected, according to the condition of the case: by rhinoplasty, using only living tissues, and by internal artificial supports.

Rhinoplasty may be complete or partial. It is termed complete when the whole or the greater portion of the nose is supplied by tissue from some near or distant part; and incomplete when a small portion only is supplied.

(1) **The Indian method,** which takes the tissue from the forehead, was originated in Hindustan. It is serviceable only in supplying nasal defects in which there is a moderate loss of tissue; for when there is destruction of the entire bony framework of the nose, sufficient material is not obtainable from the forehead to fill in the defect, and the transplanted tissue sooner or later drops through the large opening, and the nose sinks again to the level of the face.

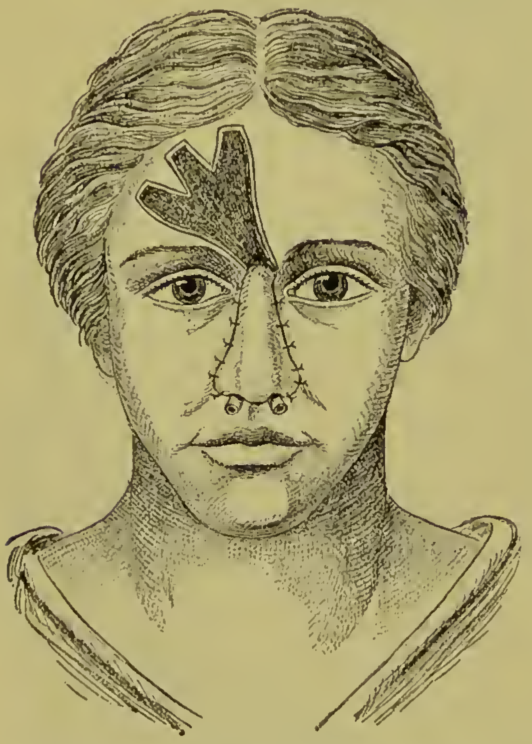

FIG. 673.—Rhinoplasty by the Indian method, with oblique flap and digitations for building the columna and alæ (Malgaigne).

In order to ascertain the size of the flap, a nose as desired is modeled of wax or plaster of Paris, and the portion that has been destroyed is outlined upon this model. Then by moulding a pattern of paper or thin leather over this model the exact size required is accurately determined, which should be made about one-third larger, in order to allow for the shrinkage of the tissues on healing. This pattern is then turned upward and spread out upon the forehead, the part corresponding to the lower portion of the nose uppermost, and outlined with ink or tincture of iodin to indicate the portion of the skin to be cut out. If the height of the forehead is not sufficient for the size of the flap, more room can be obtained by cutting it out obliquely (as shown in Fig. 673), care being exercised not to cut too near the eyebrow, lest the latter be drawn up by the retraction of the scar. The flap should be cut out by a single

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firm stroke of the knife, so as to afford an even, smooth edge. The flap is then raised and made to include the periosteum, or the anterior table of bone is included by chiselling it off, if desired, and the flap brought down and stitched into place by very fine gut, silk, or horsehair sutures.

In making this flap the pedicle should be sufficiently long to admit of being twisted upon itself, usually from left to right, so as not to compress the vessels, and wide enough to include plenty of nutrient vessels, especially the angular artery.

The low portion of the nose can be still further filled out by a flap taken from the root of the nose, made after the frontal flap has been cut out, so that all the skin of the bridge and root of the nose between the flap and the defect can be utilized. The width of this flap should be the same as the neck of the frontal flap, and left attached along the upper border of the opening. This supplementary flap is first stitched into the opening, the integument looking inward, after which the frontal flap is brought down over it and stitched into place.

Before these flaps are made the nose should be prepared for their reception by freshening the edges of the gap. Any cicatricial tissue that should be removed from the borders can be turned into the center, in the form of a flap, to assist in elevating the dorsum.

The twist in the pedicle usually forms an unsightly prominence, which can be obviated somewhat by cutting one side longer than the other, and afterward rectifying it by operation. The edges of the hole left in the skin of the forehead are then sutured together as closely as possible and any denuded space should receive a sprinkling of Thiersch grafts, so as to leave the least amount of disfigurement on healing. The coaptation of the edges is considerably facilitated by raising the skin for a considerable distance on either side so that it can be slid toward the center, care being exercised not to constrict the frontal flap. The new columna of the nose may be formed at the same time from a tongue from the forehead included with the flap, or from the upper lip, as will be described further on.

The after-treatment consists in maintaining the parts aseptic by light boric acid and bichlorid dressing very carefully applied. The dressing should not be changed oftener than required; and secondary hemorrhage should be guarded against by light pressure when it seems imminent. The flap may remain dark and edematous for some time, and finally unite most successfully. The swelling can sometimes be relieved by leeches or slight scarification.

A number of variations of this method have been practised by different surgeons, and nearly every operator has some modification peculiar to himself.

Verneuil made one incision along the median line of the depressed portion of the nose and two transversely at the base and tip respectively, and dissected up the two lateral flaps. He then raised an oblong flap of the requisite size from the middle of the forehead, leaving it adherent between the eyebrows by a pedicle, turned it directly downward, and stitched the two lateral flaps together over it; the skin of the flap lying inward, so that the raw surface came against the under surface of the lateral flaps.

(2) **The German and French Method.**—This consists in the formation of the nose from tissues taken from the side of the face. It was first proposed by Dieffenbach, and later modified by Nélaton, to avoid the frontal scar left after the Indian operation.

This operation consists in making a double flap, one from each side of the nose, including a sufficient portion of the cheek, joined together by a common pedicle at the root of the nose. These flaps are then united in the center and carefully stitched together. A pattern of the desired form is made, so that the flaps are accurately cut in such a shape as to form the column of the nose and also sufficiently long for turning in to form a double edge to the nostrils (Fig. 674), which are kept open by hollow vulcanite tubes until the healing is complete and all tendency to cicatricial contraction is overcome.

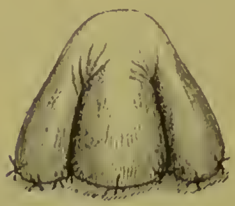

Fig. 674.—Formation of columna and alæ from the flap taken from above.

Nélaton modified this operation by making additional parallel flaps from the cheek just outside of the two primary lateral flaps; and these were brought to the center and stitched in place under the two primary flaps, which were then united along the median line of the nose.

When the tissue of the dorsum of the nose is gone and the septum is still in place, the latter can be utilized, as Mr. Bell and Nélaton suggest, and held in place by transfixing the septum and both the flaps at their outer lower edges with a straight needle. The wounds in the cheek may be partially closed by sutures, but are usually left to heal by granulation—the resulting depression adding to the relative prominence of the new nose.

(3) **The Italian or Tagliacotian Method.**—This was first practised by Branca of Sicily, by Bojani of Calabria, and Alexander Benedetti, professor of Anatomy at Padua, about the year 1495; but it was Tagliacozzi who, about the year 1587, so popularized the method by his skill and dexterity that it has since been known by his name. It consists in cutting from the biceps region of the arm a thick flap for the formation of the nose. Parallel incisions are made about four inches in length and of sufficient width to allow for the subsequent contraction on healing. This flap is raised except at the attached ends. A dressing is passed beneath to prevent reunion, and the wound, as practised by Tagliacozzi, was left open to granulate; by modern methods, however, the parts are maintained aseptic and the edges of the wound stitched together beneath the flap. At the end of about a week, when the flap has become sufficiently shrunken and hardened by exposure and covered with granulations, it is liberated at the upper portion, and then permitted to shrink still more for another week or two before it is attached to the face.

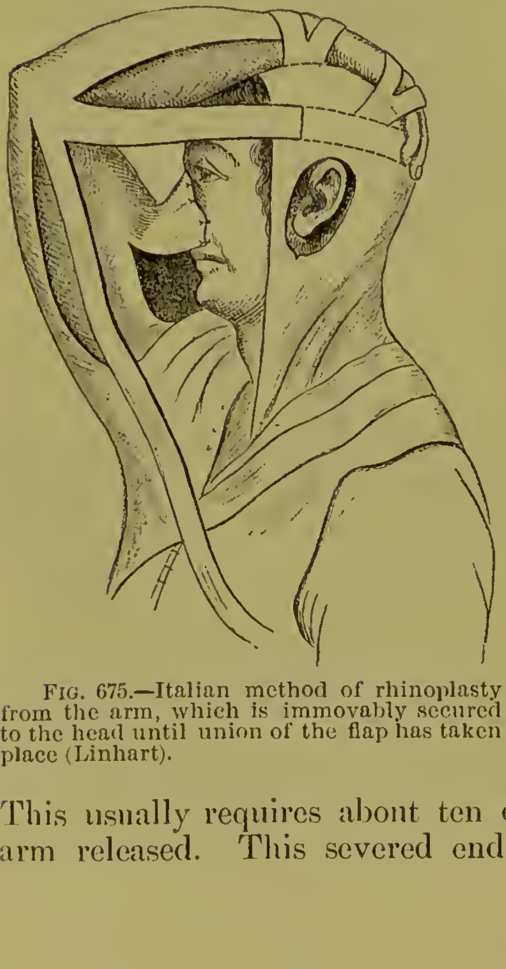

Fig. 675.—Italian method of rhinoplasty from the arm, which is immovably secured to the head until union of the flap has taken place (Linhart).

After the edges of the nasal tissues have been scarified and fitted for its reception, the arm is placed in position and the upper end of the flap carefully shaped and stitched in place. The arm is then firmly held in place by means of the cap-and-jacket apparatus shown in Fig. 675 until the vascularization between the flap and the nose has taken place. This usually requires about ten days, when the pedicle is severed and the arm released. This severed end of the flap is then carefully cut, shaped, and stitched, so as to form a symmetrical end to the nose. Owing to the painful nature of this operation and the distressing position of the arm, it is not frequently resorted to.

Von Graefe made a flap with but one pedicle, and implanted it at once. This is inferior to the original plan, as it does not obviate the constrained position of the head and arm and lessens the chances of union, and is followed by much greater shrinkage of the nose after the operation. Warren of Boston took a flap from the anterior portion of the forearm, about two inches above the wrist, transplanting the flap at once, and in some cases succeeded in separating it on the fifth day.

Partial rhinoplasty consists in supplying minor defects of the different portions of the nose, usually of the alæ, of the tip and the columna, which have been destroyed by lupus, syphilis, by injuries, or by mutilations. While less extensive, these operations are often more important to the function of the nose than the complete rhinoplasty.

Each case requires a special study and ofttimes the greatest skill in order to adapt the operation to the conditions found.

The Restoration of the Alæ.—The alæ when destroyed may be formed from the same side of the nose, from the opposite or sound side, from the cheek, from the upper lip, or by the jumping process.

The lateral flap method of Denonvillier consists in dissecting a triangular flap from the sound tissues above the defect, which can be brought down on a line with the normal wing of the nose. The vertical incision is begun just above the end of the nose, leaving sufficient tissues to nourish a flap, and is carried up about half the length of the nose, as required, where a second incision is made obliquely downward to the upper and outer angle of the ala.

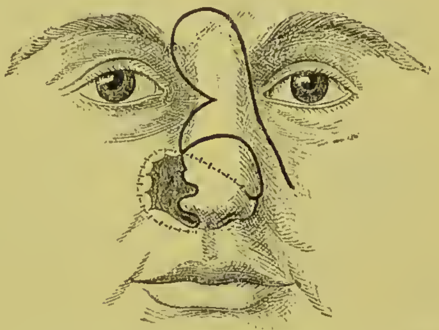

Fig. 676.—Partial rhinoplasty of ala and columna by a flap from the bridge of the nose (Linhart).

The flap may be taken from the bridge of the nose (Fig. 676), from the opposite ala, from the cheek, or from the lip, as the circumstances of the case dictate, and slid into place or carried across untouched surfaces by the jumping process.

The Restoration of the Tip of the Nose.—Mere shortness of the tip is best corrected by sliding down a Λ-shaped flap (Fig. 671). Keegan's operation consists in making a flap on each side of the bridge and base of the nose and extending the lateral incision downward to the upper border of the root of the nasal alæ. These flaps are dissected out from above downward, leaving the flaps attached at the lower border. These flaps are to be cut of the size necessary to fill the defect at the end of the nose when turned downward, sufficient allowance being made for contraction while healing.

A flap is then taken from the forehead in the usual manner, twisted and turned downward, and stitched into the place from which the other flaps have been removed. This is made sufficiently long to form the columna of the septum if lacking, the opening of the nostrils being maintained by hollow splints of the proper size and shape.

In Ollier's operation the incision is carried from a point near the center of the forehead to a point on a level with the lower border of the alæ. The skin only is dissected up from one side; while on the opposite side is included the periosteum, which underlies the upper portion of the flap, and the left nasal bone, which is separated by means of a chisel. This entire flap then is carried downward sufficiently far to form the contour of the end of the nose and stitched there, the bony portions being secured with wire sutures. The space left by the removal is filled by a bony outgrowth developed from the periosteum, slid down from the forehead to cover the opening.

In some of these cases it is possible to supply the whole defect at one operation, but quite often secondary operations are necessary to form the columna and improve the opening of the nostrils.

Restoration of the Columna of the Nose; Utilization of the Upper Lip.—Many methods have been employed for the restoration of the columna. The Italian method, though not frequently employed, consists in taking a flap from the palmar surface of the hand and suturing it in place so as to form the column of the nose, the hand being held firmly in place until the flap has become united to the nose, which is similar to the Tagliacotian method of restoration of the nose. In Heuter's method the columna is formed from the skin covering the dorsum of the nose. The flap is cut out obliquely, to facilitate its rotation into position, and so cut that the rotation takes place at the tip of the nose, which renders it thicker at that point and thereby assists in elevating the tip of the nose. For the purpose of rendering the columna more rigid he recommends that the upper portion of the flap should include the periosteum covering the nasal bones, so that the formation of osseous tissue will afford a more rigid support.

Wood's method consists in making a flap from the central portion of the upper lip, between the cutaneous and the mucous surfaces, extending downward to, but not through, the vermilion borders of the lip. This flap is turned upward and covered by flaps taken from the cheek on either side.

Dieffenbach's method consists in making two vertical incisions through the entire thickness of the upper lip, thus making a tongue about one-fourth inch in width, which is entirely freed, except at its upper attachment. This is turned upward and united to the remains of the old columna and to the alæ by fine sutures. The mucous membrane of the lip, which looks outward in its new position, soon becomes skin on exposure to the air. The cut surfaces of the lip are then brought into apposition and united exactly as in the operation for harelip.

Utilization of a Finger.—The first to make use of the finger to supply the loss of a nose was Hardie of Manchester, England, in 1875, at the suggestion of his house-surgeon, Mr. Tyler, and it was next employed by Prof. Sabine of New York, in 1879.[1]

In 1893 the writer performed a similar operation on a lad of sixteen years of age, whose nose had been destroyed by hereditary syphilis, leaving a considerable aperture, around which the skin was very much wrinkled, since it had not been destroyed, but had lost its central support, which gave the lad a very repulsive appearance. The incision was made under the lower border of this wrinkled skin, which was dissected out for the insertion of the finger. The left ring-finger was prepared by removing the last phalanx, so as to do away with the nail, was denuded of its cuticle as far up as it was to be inserted beneath the skin, and the remaining portion was split in the center on the palmar side down to the bone. The tissues forming a double flap were turned outward and stitched to the edges of the skin of the nose after the insertion of the finger in the place prepared for it. The arm was then firmly held in place by plaster-of-Paris bandages, similar to the Tagliacotian method, until the union between the finger and nose had taken place, when the finger was disarticulated at the knuckle. When the finger had become solidly united to the nose a portion of the bone of the finger was cut out, so as to leave sufficient redundant skin out of which to form the columna and the nostrils, the latter being kept open by hollow plugs.

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[1] *Illustrated Medicine and Surgery*, 1882, p. 37.

The result was at first exceedingly satisfactory; but at the end of a year the nose had very materially diminished in size, due to a settling of the finger down through the aperture between the nasal bones, which was too wide to give it support.

This method would be exceedingly serviceable in some cases where the aperture was too small to permit the bone of the finger to drop through; but in cases where this aperture is too large, this method is far inferior to that of inserting mechanical supports beneath the collapsed tissues.

The Employment of Artificial or Mechanical Supports.—The use of artificial supports is required in those cases only in which the central cartilaginous or bony supporting frame is wanting, as is often the result of the ravages of syphilis. This method was first suggested by Letievant, who inserted beneath the skin of the depressed nose a supporting framework of aluminum. C. Martin improved upon this by substituting platinum. The device as used by Martin, which is the one most commonly employed, consists of a triangular piece of platinum, bent in the shape of the nose, the upper end of which rests on the nasal spine of the frontal bone, the lower wings being supported by two arms, one on either side, the ends of which are embedded in the superior maxillæ (Fig. 677). The dimensions must, of course, correspond to the size of the nose to be supported.

The form is introduced by first performing the Rouge operation, in which the upper lip and nose are cut loose and turned up over the face so as to avoid wounding the skin, and also to gain direct access to the superior maxillæ for drilling the holes in which to securely anchor the artificial bridge. The holes should be made in the inner side of the canine eminences, about on a level with the floor of the nose, care being taken not to enter the antrum. The location of the holes should be determined by the most careful measurements, in order to bring the artificial bridge in the median line of the face.

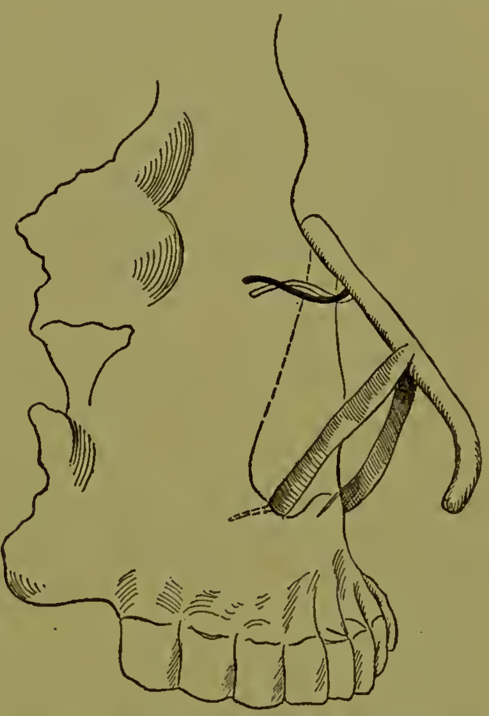

FIG. 677.—The Martin bridge as used by Weir (N. Y. Med. Jour., Oct. 22, 1892).

This apparatus has also been used by some for elevating the center of the nose in those cases of depression in which the bony framework is present. In these cases it invariably ends in failure, for it must necessarily be inserted between the skin and the osseous structure, leaving a closed space between the metallic bridge and the bone. No drainage is afforded, and sooner or later irritation is excited, the contained discharges decompose, and ulceration results. In the most favorable of these cases the device has been retained from one to five years, but in every case, sooner or later, some accident happens to the nose; or, on account of some complication, the artificial support must necessarily be removed, leaving the nose in a worse condition than before. This method of support is only successful and only necessary in those cases in which the bony support is gone and where thorough drainage takes place into the nasal cavity, thereby reducing the irritation to a minimum.

In a case where the entire central support of the nose was gone, including the entire vomer, together with the nasal and lachrymal bones, the nose being completely flattened on the face, the writer inserted a support according to the method already described. The bridge was made of hard rubber, with arms made of a gold and platinum alloy. The arms constituted one piece, a band running over the form in a groove made for its reception and securely riveted to it. This made a much lighter bridge, quite as strong and less irritating than platinum, and exceedingly satisfactory. But whatever form of bridge is used, it should be prepared as far as possible beforehand, leaving only the position and width of the arms to be adjusted to the situation of the holes made in the jaw at the time of the operation.

It is important in these cases that the most thorough aseptic precautions be observed on inserting the bridge, and that the bridge be so inserted, so moulded, and so smooth as to prevent any friction or unequal pressure upon any of the soft parts; and it is also important that the supporting arms should be buried deeply in the maxillæ, so that they are not easily displaced. Martin employed a bridge with attached arms for insertion in the maxillæ to hold the bridge in place; but the plan of cutting the bridge and the supporting arms from one piece of metal when platinum is used, as suggested by Hopkins, is far better.

Before undertaking any operation for the restoration of the whole or any portion of the nose, we should ascertain if the disfigurement is the result of an injury or disease. If the latter, we should be certain that the disease, be it syphilis, lupus, etc., is completely arrested or cured. Also before deciding on the operation to be adopted, we must thoroughly investigate the condition of the different parts of the nose and also of the face in order to determine which region, the forehead, the cheeks and face, or the arm, will best supply the requisite tissue free from scars or disease and leave the least disfigurement.

In performing these operations the greatest care and skill are required to insure the best results. Each case requires the most careful study, for as Prof. Gross has well said: "For repair of these various defects some of the nicest processes of the art and science of surgery are required," . . . and that "if the operation is entered upon heedlessly or without due preparation of the part and system, failure will be almost certain."

DEFORMITIES OF THE NASAL SEPTUM.

Of the internal structures of the nose, the septum is the part most frequently deformed, presenting deviations from the median line, spurs, ridges, hyperplastic thickenings, and exostoses.

Deviation of the septum (see page 917) may affect the whole septum or some part of either the osseous or the cartilaginous portion. It is most frequently found in the cartilaginous portion, and next in point of frequency at the junction of the cartilaginous and osseous portions, while deviation of the posterior portion of the vomer is exceedingly rare. The division of deviations into osseous, cartilaginous, and osseo-cartilaginous, as suggested by Jarvis, is by far the most natural, and further attempts at classification are unnecessary. Thickening on one side of the septum is sometimes deceptive, giving the septum the appearance of being deviated to that side, when the plane of the other side may be perfect. Sometimes the septum is curved at different parts in such a way as to give it the shape of the letter S.

In some cases the deformity may consist in the septum being located to one side of the median line, although not deflected or curved, causing one meatus to be larger than the other.

Spurs, ridges, and hyperplastic thickenings may be found on any portion of the septum, although they are most frequently found located: First, along the line of junction of the vomer with the superior maxilla; secondly, along the line of junction of the anterior border of the vomer with the triangular cartilage and the lower posterior part of the perpendicular plate of the ethmoid; and thirdly, along the line of junction of the anterior border of the ethmoid with the triangular cartilage. They may be either unilateral or bilateral. Those located along the junction of the vomer, triangular cartilage, and superior maxillæ are more often bilateral than when elsewhere.

Deviations of the septum are very often associated with deformities of other portions of the nose, and also of the superior maxilla, and with a small high-arched hard palate, approaching a scoliosis of the whole face.

The **treatment** of the different deformities of the septum consists in the restoration of the parts to their normal condition. The importance of correcting these deformities, which almost always produce more or less nasal obstruction and reflex disturbance, can scarcely be overestimated.

The treatment is palliative or radical, the **palliative** measures consisting in the removal of such conditions as may have influenced an abnormal growth of the septum, such as the removal of adenoid growths, enlarged tonsils, or of any conditions which may interfere with the proper development of the nose during infancy and childhood, and the reduction of hyperplastic thickenings by medical measures.

The **radical** treatment may consist in forcing the septum into its proper position without the employment of cutting or fracturing instruments, by exerting pressure upon the convex side by the introduction into the nostril of plugs or tents, slowly forcing it over into place; these methods are, however, usually painful and unsatisfactory, and are not to be recommended.

The more surgical treatment consists in the forcible straightening of the septum. The methods employed, according to the conditions found, are: removal of the prominent portion of the deflection with knife, chisel, saw, scissors, drills, needle and snare, or punch; destruction of the prominence by caustics, electrolysis, or galvano-cautery; incising the septum with a knife or cutting-forceps, and restoring it to position by finger pressure, by the employment of pins, or of forceps having flat parallel blades; fracturing the septum by means of comminuting forceps.

Deviation of the septum is almost always associated with spurs, ridges, exostoses, etc., which have resulted from the same cause as that which caused the deviation, and these should be removed before the septum is corrected. If the spur or ridge is cartilaginous it is most easily removed with a cartilage-knife, although good authorities recommend its removal with the galvano-cautery, and some by the use of electrolysis, inserting both poles into the outgrowth at the same time.

Osseous outgrowths are most easily removed with a nasal saw or drill, or the bone-scissors or rongeur-forceps may be employed. H. Allen lifted the lip after Rouge's method and chiselled away exostoses of the floor. The drills may be burrs of various forms or the trephines devised by Curtis, and may be driven by the dentist's treadle-engine or an electro-motor. Goodwillie and others protect the soft parts with a shield which covers the outer side of the burr or trephine.

When the spur is associated with a marked thickening of the vomer on that side, the use of the trephine, as proposed by Wright, is to be recommended in some instances. A hole is made from the anterior to the posterior end of the deviation in such a manner that it goes as close to the mucous membrane on the other side as possible without perforating it. Into this resultant tunnel a slender saw is inserted, and the exostosis is removed by sawing upward and downward from this point (see Fig. 679).

The use of the snare and transfixion-needle for the removal of cartilaginous spurs is sometimes to be commended. The portion to be removed is transfixed with the needle, and the wire loop of the écraseur is then passed over the needle (see Fig. 680) and drawn up tightly, and the engaged portion cut through.

Caustics, electrolysis, and galvano-cautery are employed in some cases if the cartilaginous spurs are not large and other operative measures are rejected by the patient. Electrolysis in these cases is very warmly advocated by Casselberry.

Forcible Correction by Forceps.—The forceps most commonly used are those devised by Adams, illustrated in Fig. 572. The disadvantage of this instrument used alone is that it will simply force the septum to the median line without correcting the usual redundancy; it is mainly serviceable in the correction of osseous deformities, because in the cartilaginous portion it does not in any degree overcome the resiliency of the cartilage. In still ruder manner Hewetson's forceps press open the stenosed naris, crushing the weakest point. Browne claims that "the crushing of the turbinated bodies and bones, and fracture of the outer wall of the nose, which must take place in some instances, appear to give rise to no troublesome symptoms."

A number of modifications of Adams's forceps have been devised. Jurasz made them with detachable handles, so that the blades could be left *in situ*, held by means of screws, after the correction was made. Garrigon-Desarenes, to overcome the resiliency of the septum, had one blade convex and the other correspondingly concave, and tightened with a screw.

Hope of New York has devised a forceps to be used in connection with the Adams forceps in operating on the cartilaginous portion of the septum. One blade has a steel pin which is received into a corresponding opening in the other blade (see Fig. 678). The operation is then marked out with a line of punctures with this pin, which so weaken the cartilage that it is easily fractured. This instrument may be used in the thin portion of the bony septum.

For the purpose of incising the cartilage so as to overcome its resiliency Steele employed a stellate punch with radiating blades (see Fig. 678), and held the parts in place by means of plugs inserted into the previously obstructed nasal chamber. Asch accomplishes this with a pair of curved cartilage-scissors, similar to buttonhole-scissors (see page 918).

J. B. Roberts uses pins for holding the deflected portion in place after the resiliency of the septum is overcome with a knife. This same plan is also adopted by Watson, after having obliquely cut the septum along its greatest convexity and set it over in the center. The pin, which should be gold-plated to avoid corrosion, is inserted either through the dorsum of the nose or from the nostril so as to hold the flaps together, and the point is embedded in the floor below or the septum behind sufficiently to hold the pin in place until the parts are united.

Gleason makes a horseshoe incision through the lower side of the deflected portion and pushes the flap through the opening thus made. A dressing is inserted on the convex side of the septum to control bleeding and to hold it in place until the parts are united.

For the correction of the osseo-cartilaginous deviation, Fig. 678 represents a pair of fenestrated forceps devised by the author in 1891 for the purpose of fracturing the septum. One blade of the forceps is fenestrated, while the other is made sufficiently narrow to fit loosely into the fenestrum of the opposite blade. The distance which the second blade passes through the fenestrum is regulated by a screw in the handle.

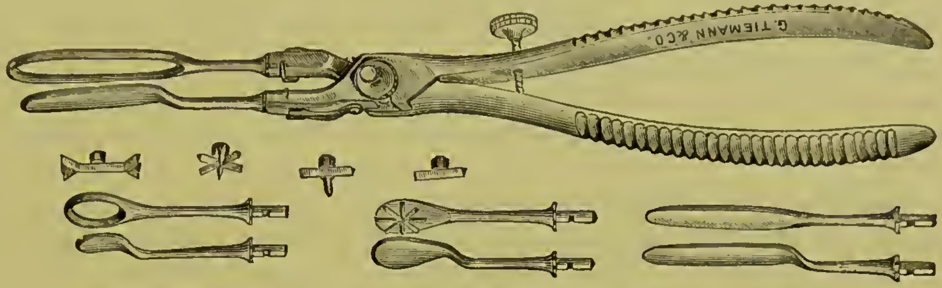

FIG. 678.—Roe's septum-forceps, with fenestrated blade for limited comminution, and interchangeable blades, making a Hope or Steele or Adams forceps as desired.

The fenestrated blade is inserted on the concave side of the septum, which is fractured sufficiently to overcome the resiliency. The advantage of these forceps is that fracture of the septum can be accomplished without wounding or lacerating the soft parts. The parts are then forced into the median line by a small nasal spatula, and a dressing is inserted on the convex side of the septum sufficient to hold it in the median line until it has become permanently fixed. These blades are detachable, and may be replaced by Adams's plane blade or by Hope's pin or Steele's stellate punches—the penetration of the latter being controlled by the screw so as to spare the farther mucous membrane, if desired.

The redundancy of tissue[1] which is frequently associated with the deviation requires removal to complete the procedure. Such projections may be removed in part before straightening, or at a subsequent operation; but it is still better to determine the extent of needed excision and to have this form a part of the main operation. Older operators were much afraid of perforating the septum, lest a permanent hole result; but with neat, clean operating there is little reason to fear any failure of the mucous membrane to unite unless there has been too much excision of tissue.

In all these cases the parts should be rendered aseptic by thoroughly cleansing them with a solution of bichlorid, 1 : 5000, both before and after the operation. The most aseptic and satisfactory form of dressing is a cotton plug, made by winding cotton over a small metal plate of sufficient size to fit the meatus. Before insertion iodoform is blown into the nostril with a powder-blower, and the plug dipped into a solution of bichlorid. If thorough aseptic precautions are taken it usually can be left for three or four days before removal. If further support is required the nostril should be re-irrigated, cocainized, and a fresh plug inserted.

Hollow splints made of hard rubber (Fig. 573) are employed by Asch and others, but they cause much more irritation, are less aseptic, and I have not found them so satisfactory as the cotton plugs.

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[1] [It is too rarely recognized that hyperplastic redundancy is the usual cause of the deviation.—ED.]

In nearly all cases if the operation is properly performed and all elasticity of the septum overcome, support to the septum is required for three to five days, until the provisional exudate is thrown out, which is ample to keep the fragments *in situ* and the septum in the median line without any return of the deflection.

DEFORMITIES OF THE TURBINATED BONES

are of not infrequent occurrence. Normally the turbinated bones project from the outer wall of the nasal chamber and turn downward and outward like a scroll, as shown in Fig. 679.

Instead of their normal bending downward and outward they are frequently twisted and distorted, projecting across the nares into contact with the septum.

Deformity of the inferior turbinated bone is frequently associated with hypertrophy of the turbinal body; while that of the middle turbinated bone is associated with a marked thickening of the bone itself, which obstructs the passage and impinges firmly against the septum, or forces it over, as shown in Fig. 545, and is the cause of much irritation, frequent sneezing, and not infrequently persistent headaches.

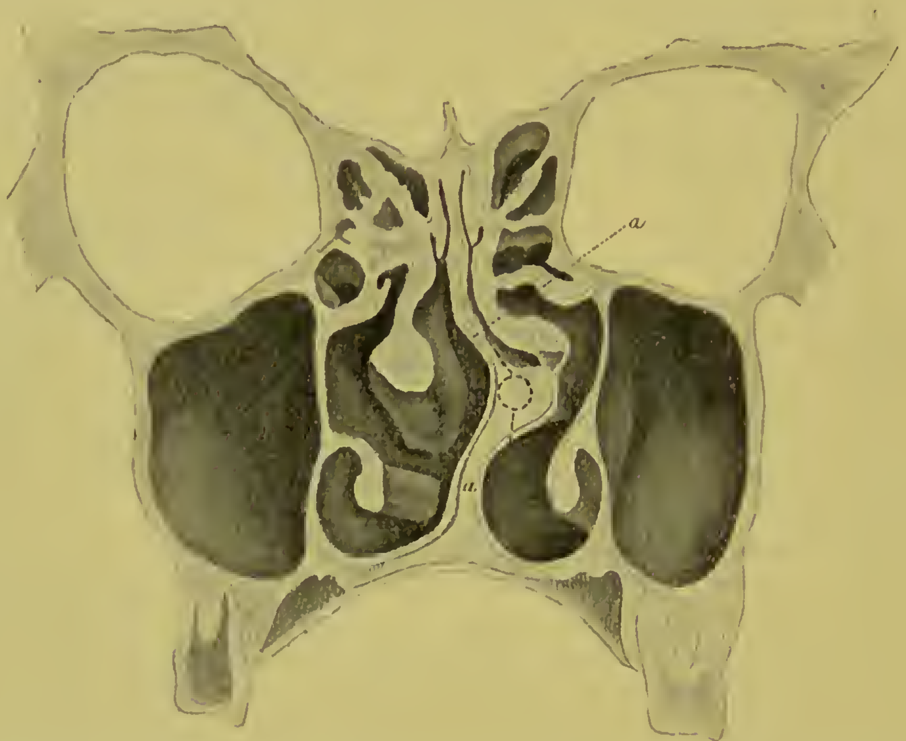

FIG. 679.—Transverse section of nasal chambers, antra and orbits, showing marked deviation and hyperplasia of the septum, with synechial attachment to the left middle turbinal. The dotted lines indicate Wright's method of drilling and sawing (Zuckerkandl).

In the case of the lower turbinated bones being distorted without hypertrophy of the soft parts, they can be fractured and bent backward, usually with a pair of nasal forceps. But the middle turbinated bone is best dealt with by sawing off the projecting portion and fracturing and forcing the remaining part backward against the outer wall of the nose with a small spatula, holding it in place by a light antiseptic cotton dressing until the bone becomes sufficiently fixed and the passage is permanently free.

Reduction of Hypertrophy of the Erectile Tissue.—The inferior turbinal bodies are more frequently found hypertrophied than any other portion of the intranasal tissue, owing to the extreme vascularity of this tissue and its sensitiveness to atmospheric changes. The next in point of frequency is the middle turbinal, and third, the erectile tissue covering the posterior portion of the septum.

The principal methods employed for the removal or reduction of these hypertrophied tissues are cauterization with chemical means or the galvano-cautery, and removal with a snare or cutting instrument.

Where the hypertrophy is small, due mainly to thickening of the interstitial connective tissue, chromic acid fused on the end of a small flattened probe gives very satisfactory results. The part should be anesthetized with cocain and then thoroughly dried to prevent the acid from liquefying and running down on parts below. After the acid is applied the part should be dried with cotton and sprayed with an alkaline wash.

Trichloracetic acid and strong lactic acid may be substituted, although less effective. The former is claimed to give a specially aseptic eschar.

In those cases in which the turbinal swelling is mainly of a vascular character, linear incisions with the galvano-cautery through the tissue down to the bone, so as to obliterate the deeper vessels, is far preferable to chemical caustics (see pages 888 and 910).

Delavan has suggested deep submucous incisions with a slender knife for severing and obliterating these vessels.

When there is a large amount of interstitial hypertrophy, as we find in chronic cases of nasal stenosis, the tissue is best removed with a Jarvis snare (Fig. 680), held in place, if necessary, by a transfixing pin.

When this tissue cannot be engaged by the snare it may be removed with nasal scissors. Care, however, should be exercised in every instance not to remove too much of the turbinal tissue, lest there result a dryness of the pharynx from lack of sufficient moisture imparted to the inspired air.

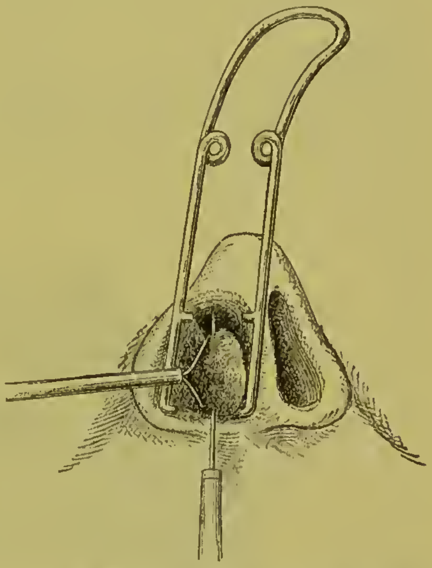

FIG. 680.—Hypertrophy of the anterior end of the right lower turbinal, transfixed by a Jarvis needle and encircled with a snare for excision.

Hypertrophy of the vascular tissue on the septum is best destroyed with galvano-cautery used very cautiously. Masses occur also on the upper portion of the septum, caused by the irritation from contact of the turbinal. These when small in amount may be removed with chromic acid, or if large they can be cut away with a nasal knife. In operations in the nose there is little or no danger of the mucous membrane failing to cover the denuded part, even after the removal with the knife of quite an extensive portion; while if destroyed with the galvano-cautery, the mucous membrane is replaced with connective or cicatricial tissue. This is particularly the case in operations on the septum.

Synechia of the nasal passages may be congenital, but is most frequently found after disease or operation in the nose when the two opposite surfaces have been denuded at the same time, granulation-tissue shooting across and uniting the parts during the process of healing. Occasionally a spur grows across into contact and becomes attached to the turbinal, when a synchondrosis or synostosis may take place (Fig. 679). It has often proven a very obstinate condition to remove, for if the band is bodily cut away it will almost invariably reform. The best plan for preventing its return I have found to be in cauterizing one side only with the galvano-cautery, after cutting the band away, for the reason that cut and cauterized surfaces do not readily grow together. Previous treatment to shrink the tissues and separate the surfaces greatly facilitates operation and cure.

Any granulation-tissue that may shoot out can be touched with chromic acid. Another excellent plan is to wear a small metallic plate covered with asepticized cotton until the parts on the two sides are healed. This method is more troublesome and disagreeable to the patient than the other.

Removal of Neoplasms.—The operative methods of dealing with these formations vary as much as the structures themselves. **Myxomata,** or nasal polyps, are the most frequent (see page 1075). They may constitute simply small polypoid growths, very easily removed, or they may be multiplied like a bunch of grapes hanging from its parent stem, or they may constitute one huge growth, occupying the entire nasal chambers and extending into the accessory sinuses.

Various agents, as chlorid of zinc, iodin, carbolic acid, alcohol, have been recommended for local application or injection into the growth; but they are rarely effective and not advisable except when the polyps are exceedingly small.

Previous to the invention of Jarvis's snare these growths were usually removed by divulsion—grasping the polyp with a stout pair of forceps and twisting it off. But with Jarvis's snare and the use of cocain these operations have been greatly improved. Fig. 681 represents the application of the snare to a polyp in the nose.

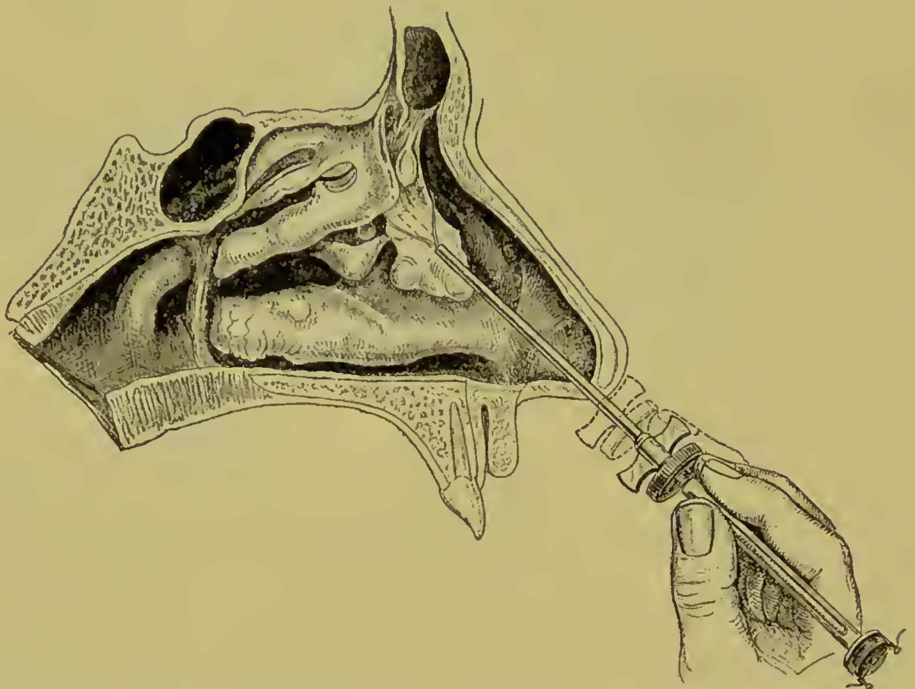

FIG. 681.—Polyp descending from the infundibulum engaged by the snare loop, which is tightened to secure it by pushing forward the cannula (after Zuckerkandl).

The snare, armed with a No. 5 piano-wire, is carefully introduced over the growth, then by a gentle forward-and-backward movement it is worked up as near the base of the growth as possible before tightening. This is best done by holding firmly with thumb and index-finger the outside tube to which the wire is attached while the cannula is forced forward by the middle finger pressed against the nut. Escape of the growth is thus avoided; and after it is secured, the cutting is done by screwing down the nut as fast or as slow as seems best.

The return of the growth can often be prevented by cutting the pedicle with a slender knife, taking a portion of the periosteum or a scale of the bone with it.

In case the polyp involves the whole of a turbinated bone, it may be necessary for the eradication of the growth to remove the entire bone.

If the growths are small, I have found the interstitial injection of a saturated solution of bichromate of potash into the neck of the growths exceedingly effective in not only destroying them but preventing their return.

When the ethmoid cells are involved they require curettement in order to reach the deep portions of the growth.

After removal of the growth the parts should be kept clean with an antiseptic wash and carefully inspected. Any recurrence or small portion that escaped removal should be removed or destroyed. The patient, at frequent intervals, should return for an inspection, to insure against a return of the growth.

Fibroma and Angioma.—In the removal of myxomatous growths and nasal polypi very little hemorrhage is encountered; but in cases of the firmer and more vascular growths it is often profuse. This is best avoided by using the galvano-cautery loop or the cold-wire snare. In the use of the galvano-cautery loop care should be taken not to have the wire too hot. If brought to a dull-red heat only, it closes the vessels as it passes through the tissue; but if raised to white heat it cuts through quickly like a knife, and leaves the vessels open. In one case of angioma of the nose the writer removed a portion with the galvano-cautery loop which was followed by profuse hemorrhage, requiring plugging of the nose; whereas a very much larger portion of the same growth was removed very slowly with the cold-wire snare, and all hemorrhage was avoided.

The chief difficulty of removing from the nose large growths with the snare is in engaging the growth in the loop. This is most easily accomplished with a small flexible copper wire having a shot attached to one end and a stout silk thread to the other. The head of the patient is thrown backward and the shotted end insinuated along the upper side of the growth. When the shot has reached the posterior wall the head of the patient is erected and the shot is slowly pushed down into the pharynx.

A similar one is passed through the lower meatus below the growth, when both wires are grasped with a pair of forceps and pulled out through the mouth. The copper wire is then removed and the ends of the thread tied together, when, with the aid of the finger behind the soft palate, the thread can be drawn up around the base of the growth. One end of the thread, preferably the upper end, is then attached to the steel or platinum wire with which we wish to encircle the growth and drawn round it and attached to the instrument for removal. In this manner some of the largest growths of the nasal passages may be removed with little risk of hemorrhage.

In some cases in which it is impossible to pass a loop around the growth, before recourse is had to the knife, electrolysis, best applied by the bipolar method, will sometimes be successful in arresting if not obliterating the growth. The bipolar needle should be plunged directly into the base of the tumor, and the current employed should be as strong as the patient can comfortably endure, cocain, of course, being first applied.

Enchondroma of the nose, as well as the septal ecchondroses, can usually be removed with a knife. In some cases it may be removed with the snare or with the galvano-cautery. Electrolysis has been commended, but seems to the writer a tedious and useless procedure when the outgrowth can be so quickly and effectively cut away.

Osteomata found in the nose are of two varieties, one being composed of cancellous and the other of ivory structure. They are usually located in the upper part of the nares, and may involve the accessory sinuses, often causing fetid discharges and pain from pressure. They are usually attacked with the saw or drill, the ivory variety being often removed only with the greatest difficulty, unless the point of attachment yields readily to the chisel or other instrument.

Malignant growths should, if possible, be totally extirpated, otherwise the partial removal tends to increase the rapidity of their growth. Partial removal may, however, in some cases be expedient. In sarcomatous growths the galvano-cautery loop will sometimes be successful in arresting the advance. A case of the kind was reported by Lincoln, in which the thorough removal of the growth with the galvanic snare caused the complete arrest of the growth for years.

In the case of carcinoma, it is only through complete extirpation of the growth that success is attained. The most radical and effective method of reaching the interior of the nasal chamber is that devised by Rouge of Lausanne, which consists in dissecting up the upper lip close to the superior maxilla, together with the whole soft structures of the nose, and turning them backward over the forehead, when the nasal chambers come plainly into view and become directly accessible for any operative procedure. Partial or total resection of the bony parts may be temporarily made, or the superior maxilla or other parts may have to be excised.

Coley reports many cases of sarcoma successfully treated with serum of streptococcus and bacillus prodigiosus. I have succeeded in destroying a sarcomatous growth with the injection of a saturated solution of bichromate of potash, already referred to in connection with polypoid growths.

EVACUATION OF ABSCESS OF THE NASAL CAVITY.

Abscess of the septum may result from an injury or other causes (see pages 899 and 1117).

The **treatment** consists in the evacuation of the pus by a free incision with a small nasal bistoury. The cavity should then be washed out with a bichlorid or hydrogen-dioxid solution injected into it. When the abscess is bilateral an incision is required in one side only, for the reason that the two sides almost invariably communicate. The cavity is then kept collapsed by pressure on each side by means of a suitable dressing placed in each nostril. This should be removed and the parts cleansed and dressed daily until cured.

This condition must not be mistaken for a hyperplasia on the septum or an ecchondrosis of the cartilage. The question is quickly settled by exploration with a probe.

Abscess of the turbinal body sometimes occurs as the result of inflammation of the turbinated bone going on to necrosis. Sometimes these abscesses are chronic, and the discharge mistaken for that originating from an accessory sinus.

The **operation** consists in the free opening of the abscess and the removal of any necrotic bone that may be present, which is best done by a small burr run by an electric motor. The dead bone can be eradicated in this manner without cutting away the turbinal, which should be removed only when entirely diseased.

BONY AND CICATRICIAL OCCLUSION OF THE POSTERIOR NARES.

Bony occlusion of the posterior nares is often congenital. In operating for its removal the size and extent should first be ascertained by the combined exploration of the anterior nares with a curved probe and with the finger in the posterior nares. When this is determined it should be removed with either a drill or bone-cutting forceps. Great care must be exercised, for the position of the bony formation frequently renders the operation extremely hazardous. In the case of a child that recently came under the care of the writer, the posterior nares were completely closed with a firm bony formation which had existed from birth. This was removed with a Curtis drill passed along the floor of the nose; when an opening had been made, one blade of a small right-angular bone-cutter was passed through and the bone chipped off until an opening of the requisite size had been made. Cicatricial tissue may close the opening secured, and must be removed as fast as it forms. Trichloracetic acid has been praised as the cautery least apt to be followed by return of the occluding tissue.

Stenosis of the naso-pharynx due to the adherence of the soft palate to the pharynx may be congenital or it may be due to ulceration resulting from acute inflammation, as in diphtheria, from struma or tuberculosis; but is most commonly the result of syphilis, which in children may be hereditary, but in adults is usually acquired. The stenosis is rarely complete, there being nearly always a small opening between the two cavities. Complete stenosis in the case of a child recently came under my observation.

The readiness with which severed cicatricial adhesions reunite renders these operations extremely unsatisfactory; accordingly a great many devices have been resorted to to prevent reunion of the parts after having been separated, such as the insertion of rubber tubes, plates of hard rubber, metal rings, air-bags, and mechanical dilations. The most successful plan is that devised by Nichols, who with a curved needle passes a heavy silk thread through each side of the cicatricial tissue and ties it in the center. The knot is then slipped around back through one of the openings so as to be entirely out of the way, lying in the naso-pharynx, and is allowed to remain there until complete cicatrization has taken place around the thread in a manner similar to the treatment of web-fingers. The string is then removed, and by inserting an angular knife in one of the openings the adhesion between the two openings is cut away.

The best plan for keeping the cut surfaces apart until healed is by means of a small flat piece of hard rubber attached to and held in place by a string passed through each nostril and tied in front of the septum. In some cases daily dilatation of the parts is necessary to maintain the proper size of the opening, and in moderate stenosis only such dilatation may be necessary.

SURGICAL INTERVENTION IN DISEASE OF THE ACCESSORY SINUSES

has been dealt with earlier (page 966), and but few points need be here added.

Maxillary Sinuses.—The disease of the maxillary sinus most frequently necessitating surgical interference is empyema. There are five methods for gaining access to this cavity: (1) Through the natural opening;

(2) through a tooth-socket or alveolus; (3) through the canine fossæ or the canine eminence or the malar ridge; (4) through the inferior meatus; (5) through the hard palate.

Acute or subacute inflammation of the antrum can frequently be treated successfully through the natural opening, which in most cases is easily found with Hartmann's, or preferably with Myles's, silver tubes (Fig. 593). The second method, however, is the one most frequently resorted to, because it is the easiest and, as a rule, causes the least disturbance to the patient. In many cases the floor of the antrum is divided into separate compartments by septa. It is therefore important that the internal orifice of the opening through the alveolus should be wide enough to include and cut away any septa that may be present in order to afford free drainage. In many cases it is advisable to make the opening long and narrow and wider on the inside by separate insertions of the drill; or the two outer holes can be made a short distance from each other and the intervening space sawed out. By making an oblong opening in this way the food does not so readily enter, and in nearly every case a tube can be dispensed with. When a tube is required, Myles's soft-rubber tube (Fig. 590) is the best.

Some authors advise making a very small opening, which, in the experience of the writer, is unpractical, as it does not afford sufficient room for the exploration and free drainage of the cavity or the removal of growths, which are frequently found to be the exciting cause of the discharge. In case the premolar teeth are sound or a very large opening is necessary, it is best made through the canine fossa. In cases of growth in the antrum, it is frequently necessary to make a very large opening to permit free inspection of the interior and thorough removal of the growth.

The writer's method of opening the antrum through the canine fossa is first to incise and turn back the soft parts where the opening is to be made, then to drill a small hole near the lower side, which permits a preliminary exploration of the interior of the cavity with a probe to determine its size and shape. A slender saw is then introduced through this hole, and a circular button of bone of the desired size is sawed out of the anterior wall. It is usually desirable to make the opening sufficiently large to freely introduce the finger, which is a valuable aid for exploration. This large hole also affords ample space for the removal of growths or other diseased conditions and a ready access for treatment. This method of removing the bone with a saw I have found to be far superior to the use of the chisel commonly resorted to.[1]

When the outer bony wall of the nasal chamber is thin, an opening through it is easily made with a small curved trocar and cannula; but when this wall is firm, it is best made with a curved spiral drill attached to an electric motor. This method has often been found serviceable in recent cases, but it is not a route generally to be recommended, for the reason that the floor of the antrum is frequently much below the plane of the floor of the nose, and discharges from the nose will find their way into the antrum. It is also impossible through this opening to remove growths or to explore or properly treat the antrum when extensively diseased.

Opening through the hard palate is sometimes resorted to, and conditions may arise where it is the most advisable method, although generally it is not to be recommended, on account of the readiness with which food and other substances may be forced through the opening from the mouth.

Disease of the Ethmoid Cells.—Disease of the ethmoid cells is very often associated with nasal polyps, and in these cases the anterior ethmoid

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[[1] Dr. Myles's opening further back is described on page 974.]

cells are most frequently affected; but when there is necrotic condition of the turbinated bone, the posterior ethmoid cells and also the sphenoid cavity are also very frequently involved. When unassociated with nasal polyps, the tissues covering the middle turbinated and ethmoid mass frequently have a boggy, doughy character and a pale color, resembling a polyp. In other instances the enlargement of the turbinal consists of a true connective-tissue hypertrophy, causing pressure on the septum and much reflex disturbance. In some cases the bone is denuded, which is very readily detected with a probe, and has been termed by Woakes "necrosing ethmoiditis." This condition is usually attended with purulent discharge, headache, supra-orbital and peri-orbital neuralgia, and sometimes the vision in the eye of that side is interfered with, or choked disk is found on ophthalmoscopic examination.

The only effective treatment is free opening of the cells and curettement of the diseased portion. In order to reach these cells, more or less of the turbinal body requires removal. A boggy hypertrophy of the middle turbinal bodies is best removed with a Jarvis snare, which is frequently employed for removing the turbinated bone; but for this purpose Myles's cutting-forceps is preferable, for the crushing of the bone by the snare is not desirable. Burrs and drills are employed by some. Bosworth employs a burr run by a hand motor, and depends largely upon the sense of touch with the instrument to locate the point for operation. This method, however, is hazardous, except for one thoroughly skilled in these operations. When the cells have been freely opened and sufficiently curetted to break down all the diseased cell-walls, the cavity should be thoroughly washed out with an antiseptic solution and packed with iodoform or sublimate gauze. This should be renewed as often as required, usually daily, and the healing process stimulated by mopping with a silver-nitrate solution, 30 grains to the ounce. If the purulent discharge continues, it indicates that all of the diseased cells have not been reached, or that the discharge comes from a neighboring sinus, which should be investigated.

Disease of the Sphenoid Cavity.—As already stated, disease of the sphenoid cavity is often associated with disease of the ethmoid cells and maxillary sinus, and is usually determined by tracing the source of the pus, aided by the use of the aspirating needle, or exploration with a probe. The opening in the cavity can sometimes be found by passing a probe directly backward along the lower border of the middle turbinal body, using that as a guide. Oftener it is higher and more lateral, so that the probe must curve outward and cross the posterior third of the turbinal (see Fig. 682). Empyema as in the maxillary sinus can also be determined by the effervescence on injecting into the cavity a small quantity of hydrogen dioxid. This cavity sometimes becomes the seat of polypoid or other growths and degenerated tissue, requiring curettement. In simple empyema the cavity should be washed out and medicated with a syringe having a long, slender nozzle.

Other diseased conditions frequently require a free opening of this cavity, which can be made by drilling through the anterior wall. This can safely be done by first ascertaining the distance of the anterior sphenoid wall from the end of the nose and marking the distance on the drill; then by allowing sufficient for the penetration of the wall of the cavity, we know exactly the distance beyond which the drill should not be passed. Ordinarily the entering of the drill into the cavity is at once perceived by the operator. When a sufficient opening has been made by the drill or the rongeur (see page 984), the growths or other diseased tissues are removed by curettement, the cavity is cleansed with an antiseptic solution and packed with iodoform or sublimate gauze, as in the case of the ethmoid. Afterward the cavity requires frequent irrigation with a medicated solution until the parts are healed. After irrigation of the cavity the head should be held downward in such a position that the cavity will be entirely drained.

Disease of the Frontal Sinuses.—Disease of the frontal sinus is almost invariably associated with disease of the nasal cavity—most commonly polypoid growths or enlargement of the middle turbinal—obstructing the infundibulum. Empyema of the frontal sinus is most frequent, although it may be the seat of growths and degenerations. The disease of this cavity is indicated by the flow of pus from the upper portion of the semilunar hiatus, and by pain and tenderness to pressure over and around the eye.

The treatment of frontal-sinus disease is by drainage and injections of medicated solutions into the cavity. This can be reached by two routes: through the infundibulum or natural opening, or by an external incision through the bony wall. Through the infundibulum a slender silver catheter may be passed and the sinus irrigated and medicated, and in recent cases a cure is effected in a short time; but in chronic cases it must be reached through an incision in the outer wall. The incision should be made along the eyebrow, and the tissues raised and turned backward a short distance to give room for opening the bone. The cavity is best entered just above the supra-orbital ridge with a small drill run by electric motor, controlled by a foot-switch. Through this opening the cavity can be explored and its size and the relations of its walls ascertained. A larger drill can then be employed, or a button of bone taken out with a trephine, or the portion of the wall sawed out with a slender saw, as in opening the antrum. Luc adopts the plan of making a vertical incision from the root of the nose upward and so raising the soft parts that the opening through the bone is made under the flap just outside the median line, so that the two wounds will not come opposite each other. When the opening has been made, the cavity is curetted or dealt with according to the conditions found. A Bryan soft-rubber drainage-tube is then inserted through the natural opening into the nose, the flange on the head of the tube remaining in the cavity to keep the tube in place, and through this the cavity is irrigated and medicated from below. The external wound is then closed in the usual manner. It is important that the line of the incision, when horizontal, be made along the line of the eyebrow, so that the scar will be obscured by the hair.

TONSILLAR OBSTRUCTIONS IN THE NASO-PHARYNX AND FAUCES.

The most frequent obstructions in the naso-pharynx are adenoid growths or enlargements of the pharyngeal tonsil (see page 952), although nearly every known variety of growth is encountered in this region. A variety of methods is employed for the removal of these growths, as curettement, the use of cutting- or divulsion-forceps, scraping them out with the finger-nail, or burning them away with galvano-cautery. These methods are applicable to the different conditions of the growth. When it is one rounded mass it is best removed with Löwenberg's postnasal adenoid forceps, having a posterior scooped projection, as shown in Fig. 682. When composed of independent vegetations scattered about the pharynx (Fig. 583), the simple ring-knife or Göttstein's curette may be chosen. When the mass is soft and spongy, it is very easily scraped away with the finger (Fig. 683) or with Darby's artificial fingernail-attachment. When it is firm and more or less pedunculated, it is often best removed with a postnasal snare curved to pass up behind the soft palate. In children the use of a general anesthetic is always advisable unless there is some counterindication to its use. Chloroform or Schleich's mixture is the most satisfactory, and the operation as performed by the writer is as follows:

The child is anesthetized, a mouth-gag introduced—with its head slightly dependent. The tongue is then depressed and the chosen instrument introduced behind the palate and the growth removed. The child is then placed on the side, preferably the right, if the operator is right-handed, so as to allow the free escape of the blood without the danger of its being inspired into the larynx. The vault should then be digitally explored to determine if every part of the growth has been removed, which should be done before the operation can be considered completed. After the operation the vault of the pharynx can be irrigated with a postnasal syringe, using a bichlorid solution, 1 : 5000, for the purpose of removing blood and rendering the parts aseptic.

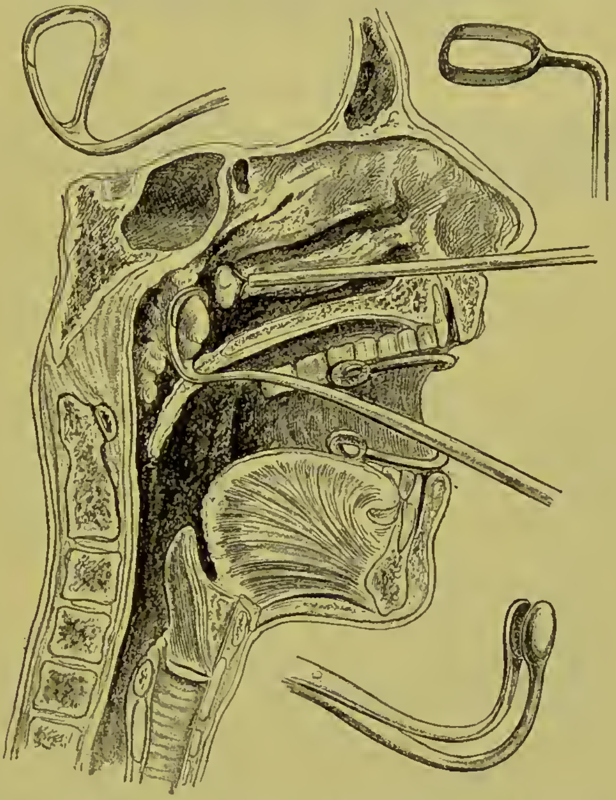

FIG. 682.—The Gottstein curette (its blade shown also above to the left) applied for the removal of the pharyngeal tonsil, the mouth being held open by a gag. A snare is also shown engaging a posterior turbinal hypertrophy through the naris. The Hartmann curette is shown above and the Löwenberg forceps below, to the right.

Further treatment than this is unnecessary, and often this can be dispensed with by thoroughly cleansing the parts with an alkaline solution used before the operation.

In operating on adults anesthesia, except by cocain, is rarely required. After the growth is removed the conditions that may have resulted from the presence of the growth, such as deafness and the imperfection of speech in children, must be properly dealt with.

Formerly the galvano-cautery was frequently employed in the removal of adenoid growths; but the danger of middle-ear complications attending its use in the postnasal space and the greater or less difficulty in its application, together with the superiority of other methods has caused it almost entirely to fall into disuse for this purpose.

Harrison Allen, Hooper, and others raise the child into a sitting posture for operation and incline it forward to let the blood flow from the mouth and nose; Allen using generally the alligator-forceps through the nose, guided by the finger in the pharynx, which is able also to squeeze out the softer masses as well as tear away the firmer. After the central mass has been removed, Hartmann's lateral-cutting curette (Fig. 682) may be used for the removal of any marginal portions remaining in Rosenmüller's fossæ or elsewhere. When there is recurrence of the growth it is due to some portion of this lymphoid tissue which has escaped removal.[1] In exploring and operating with the finger a guard (Fig. 683) is useful, and can sometimes supersede a mouth-gag.

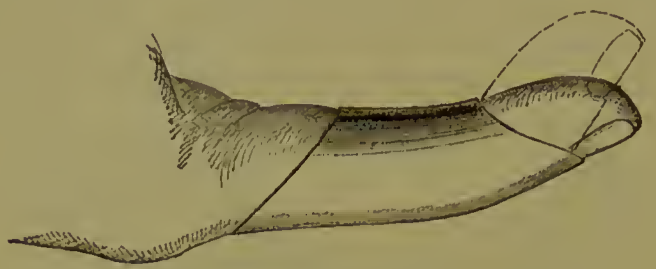

FIG. 683.—Metal finger-guard, serving also as mouth-gag during digital examination and erasion in the pharynx-vault. Its bevelled end can wedge open the teeth if set, and, while fully protecting, it permits sufficient motion.

The **removal of the faucial tonsil** is called for in cases where it is enlarged sufficiently to project beyond the pillars of the fauces and cause obstruction or act as a foreign substance, or when the tonsil is not hypertrophied, but so diseased as to cause irritation of the fauces and more or less reflex disturbance. There are two principal methods for the reduction or removal of the tonsil—destruction by means of caustic substances and excision with cutting instruments.

The caustics employed are Vienna paste, chromic acid, nitric acid, nitrate of silver, chlorid of zinc, and the galvano-cautery.

Before the application of the caustic the tonsil should be anesthetized with cocain, or by the injection of Wilson's local anesthetic around the base of the structure. Where the Vienna paste is used, it is applied by mixing it with water to the consistency of a thick paste and rubbing it upon the tonsil with a small glass rod, care being taken that no paste be allowed to drop into the fauces.

Nitric acid is best applied with a very small pledget of cotton wound on the end of a probe, as may the saturated solutions of the other caustics; or crystals of chromic acid, silver nitrate, or chlorid of zinc may be picked up or fused on the end of a probe.

The galvano-cautery is most effectively employed by ignipuncture, using a slender-pointed electrode (Fig. 568), which is thrust into the tonsil at several different places, rather than burning away the tonsil *in toto*.

None of these processes is to be recommended, however, except as a substitute for the knife when its use is not permitted.

The only positively satisfactory and effective method is excision. This

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[1] [While some recurrence is possible, that observed is generally due to the growth toward the free median space of adenoid tissue left at the sides. "Total removal" of lymphoid tissue, which commonly extends into the Eustachian tube, is neither safely possible nor desirable; but all that is obstructive or likely to become so should be removed, preferably by expression, since this destroys the smallest amount of mucous membrane.—ED.]

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may be done with a bistoury, with the tonsillotome, with the cold-wire snare, or with the galvano-cautery écraseur.

The bistoury employed should be slightly curved and have a blunt probe-point to prevent the wounding of the pillars of the fauces and to lessen the danger of cutting too deeply. The tonsil is removed by grasping it with a pair of forceps, dragging it from its base, and cutting off the diseased portion. In cases of flattened or lobulated tonsils the bistoury is a very practical instrument for the removal, especially in adults, although in many cases the writer gives preference to the cold-wire snare.

In children where the tonsils are found plump and rounded the tonsillotome of Mathieu or Mackenzie is very serviceable, although in these cases, also, the cold-wire snare is preferable.

In the use of the tonsillotome the patient is seated upright and the head held by the assistant. The tongue is depressed and the ring of the instrument is passed from below over the tonsil and well in behind it (Fig. 684).

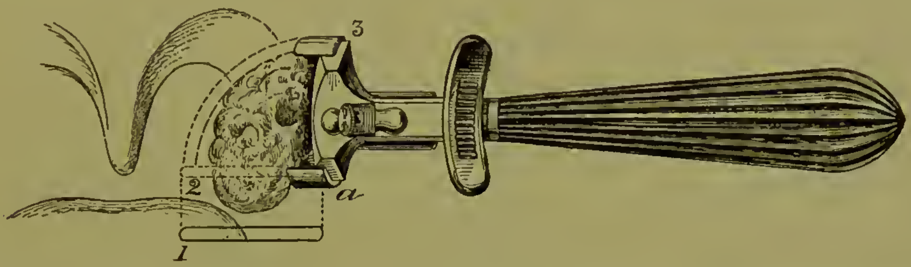

FIG. 684.—Diagram showing the method of applying the Mackenzie tonsillotome (after Hovell).

The assistant presses with one finger on the outside of the neck directly over the tonsil, forcing it inward toward the fauces, so that it may the more fully enter the ring, and the guillotine-knife is then carried through the tissue, cutting off more than a surface slice.

Before the tonsils are excised they should be thoroughly liberated from the pillars of the fauces by a curved blunt instrument. This I regard as an exceedingly valuable procedure, as the tonsils are so frequently adherent to the pillars that unless liberated there is danger of cutting the enlarged blood-vessels of the pillar, which, if wounded, may bleed profusely or cause the alarming hemorrhages that occasionally follow tonsillotomy in adults.[1]

When portions of the diseased tonsil escape removal, it is frequently necessary to finish the operation by grasping these portions with vulsellum forceps and removing them with the cold-wire snare or bistoury.

In cases where hemorrhage is apprehended, the tonsil is best removed by means of the cold-wire snare or galvano-cautery écraseur, as in no instance has hemorrhage of any considerable extent followed the use of the cold snare.

The removal of the tonsils with the cold-wire snare or the galvano-cautery snare is done in the same manner as the removal with the tonsillotome, except that the tonsil is drawn outward with a pair of vulsellum forceps passed through the loop.

Luc of Paris and Farnham of Boston have devised punch-forceps for the removal of enlarged tonsils, which I have found in some cases serviceable, particularly in removing remnants of tonsils that have escaped excision. Bliss employs scissors to dissect away the entire structure and Pynchon does this with the galvano-cautery knife.

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[1] J. Wright collected from literature some years ago 31 cases of bleeding after tonsillotomy—2 fatal; but this was out of a total of probably 100,000 operations.

In the removal with the galvanic snare allowance should be made in the adjustment of the loop for the portion of the tonsil that will slough away as a result of the burning.

In case of hemorrhage following excision of the tonsils the instrument always at hand and generally the most serviceable is the two large fingers of the hand corresponding to the side on which the operation is performed. The fingers are thrust into the tonsil, with the thumb pressing firmly on the outside of the neck. The writer has never seen a tonsillar hemorrhage that could not be controlled in this manner. In all ordinary cases the pressure for a short time will suffice for the complete arrest of the hemorrhage; but if there is a tendency to recur, pressure can be exerted in the same manner by Pendim's instrument.

With our present knowledge of tonsillotomy, the wounding of the deep blood-vessels of the fauces sufficiently to give rise to such alarming hemorrhages can only be justified or excused by an anomalous distribution of the arteries, which ought to be recognized beforehand by palpation or by their visible pulsation on careful inspection.

Operations on the Lingual Tonsil.—When the enlargement consists mostly in a vascular engorgement, the best method of reduction is with the curved galvano-cautery electrode having a slender point. By the aid of the laryngeal mirror the large vessels can be singled out and destroyed separately by burning deeply. On healing, the contraction of the tissues will cause obliteration of the intervening engorgement. For this purpose caustic agents are also used, such as chromic acid, nitric acid, and Vienna paste. These, however, are not to be advocated, as the use of them is painful and unnecessary.

Where the enlargement consists in hypertrophy of the interstitial connective tissue, it is best removed by excision. When the mass is more or less rounded and projecting, I have found the instrument devised by myself and termed a lingual tonsillotome, as represented in Fig. 685, exceedingly serviceable. The lower portion of the ring is caught under the lower edge of the growth between it and the epiglottis, and by pressing forward and downward the mass is forced through the opening, when the blade is shoved down and the whole mass severed, leaving a smooth surface.

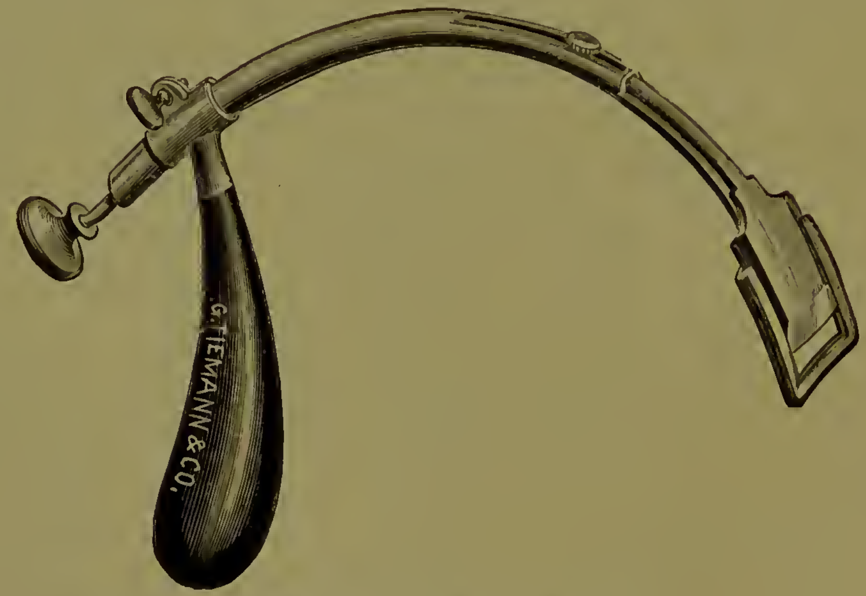

FIG. 685.—Dr. Roe's lingual tonsillotome.

In cases in which the hypertrophies are in the form of little lobules scattered about the base of the tongue, I have for a considerable time used the cold-wire snare having a curved stem to pass over the base of the tongue. But a small portion can, as a rule, be removed at a time, consequently a number of efforts are required to remove the entire mass. This method is, however, exceedingly satisfactory, causes little pain, and bleeding is rarely encountered.

In the removal of these growths it is important to adjust the instrument by aid of the laryngeal mirror, the tongue being drawn forward by the patient, in order to avoid injuring the epiglottis. Every portion of the growth should be removed, for if one or two small lobules remain behind, the irritation produced may be nearly as great as that caused by the whole mass.

EVACUATION OF FAUCIAL AND PHARYNGEAL ABSCESS.

Quinsy or peritonsillar abscess is rarely if ever a suppuration of tonsil-tissue, as it was formerly considered, although generally the result of phlegmonous inflammation from tonsillar infection. Scarification of the tonsil itself is in most cases as needless, therefore, as in retro-pharyngeal abscess. Fluctuation is to be sought by palpation, aided, if possible, by simultaneous ocular inspection, and incision should be made as soon as pus is detected or is clearly unavoidable. Harrison Allen probed carefully each tonsillar follicle, seeking a boggy point, and could often thus find and evacuate the first drops of pus, to the great shortening of the affection. The relief to the patient may be great even before pus is formed, while with the evacuation of the abscess most of the pain and distress of the condition is at an end. The thin region of pointing may perhaps be better recognized by touch than by sight, and pulsation is to be felt for, both as to its indication of the proximity of large arteries and because an aneurysm might be opened by mistake. The incision should be free, usually in or just inside of the anterior half-arch above the tonsil, entering the blade nearly half an inch and cutting horizontally in toward the median line; and vigorous use of the probe may be needed to fully enter and empty the flabby sac. Hot syringing with mild disinfecting solutions is usualy advisable.

In the retro-pharyngeal abscess it is easier to evacuate the cavity; and lest it should deluge the air-passages and perhaps be drawn into the lungs, some open at its upper rather than at its most dependent portion. In these cases the possibility of extrinsic origin in adjacent lymph-gland, mastoid or vertebral suppuration must not be forgotten, and search should be duly made for any such condition. Where the retro-pharyngeal pointing is merely accidental and external operative intervention is needful, it may be better to drain outward without pharyngeal opening. In any of these cases the danger of wounding the large blood-vessels of the neck is much greater than in tonsillotomy.

UVULOTOMY.

It frequently happens that the uvula is cut away because it is the supposed cause of irritation which in reality originates from diseased conditions of other parts, and it is safe to affirm there is no organ in the body which is so often abused for fancied sins as the uvula.

It occasionally happens, however, that the uvula requires shortening, and for this purpose a variety of instruments have been devised: fenestrated instruments similar to the tonsillotome, curved scissors with the ends coming together first so as to prevent its slipping away, and others having a pair of claws to seize the cut portion to prevent its falling into the larynx. Some advise the use of the snare, in order to avoid any danger of hemorrhage, which sometimes, although very rarely, occurs.

The simplest and, as I consider, the best method of removing the elongated portion of the uvula is to grasp the end with a pair of mouse-toothed forceps, pulling it gently forward, and with a pair of grape-vine scissors cut it on the slant so that the cut surface looks backward. This is important for two reasons, first, it prevents food from coming in contact with the cut surface, and it directs the mucus or fluids from the nasal space forward upon the base of the tongue, thereby preventing it from falling into the larynx.

In cutting the uvula particular care should be exercised not to cut it too short, allowance always being made for considerable contraction after healing to prevent its becoming shorter than its normal dimensions.

After uvulotomy some cases of hemorrhages have been reported. Morgan collected a number of such cases scattered through medical literature, and devised a clamp which can be applied to the end of the cut portion. This the writer has found in some cases exceedingly serviceable.

INTRALARYNGEAL OPERATIONS.

Papillomata and polypoid growths of the larynx are best removed by means of forceps, such as Mackenzie's (Fig. 686), guillotine, such as Stoerk's, or rongeurs, such as Krause's. The choice of instrument depends much upon the form and seat of the growth and the facility of the operator.

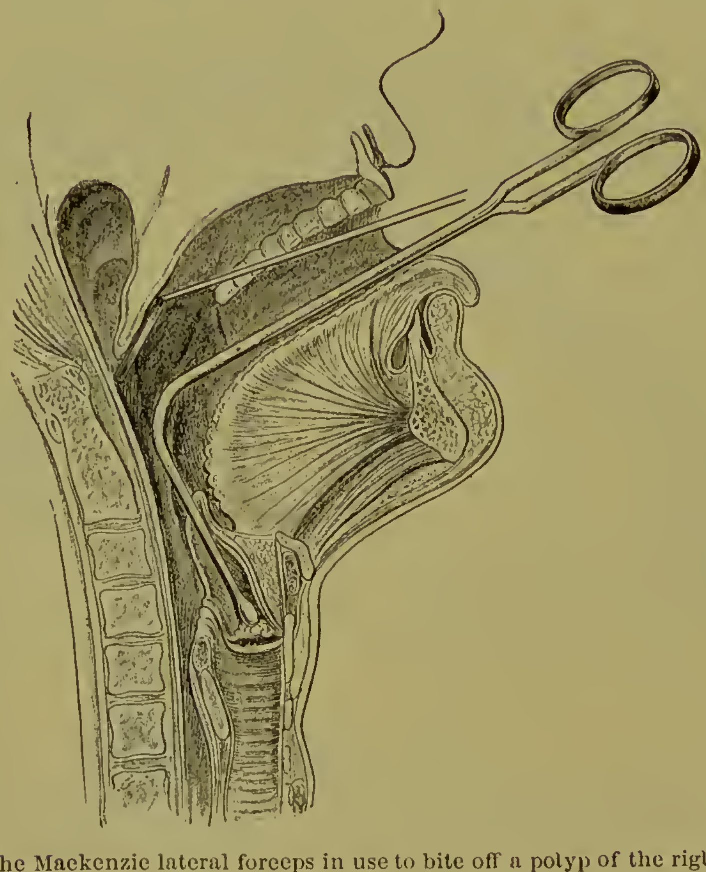

FIG. 686.—The Mackenzie lateral forceps in use to bite off a polyp of the right ventricle.

The removal of foreign bodies is often a closely similar procedure, both being guided, as a rule, by the mirror. The reversal of the image will confuse an inexperienced laryngologist, and the patient may need some drill to secure steadiness and the co-operation sometimes required; so some preliminary use of the probe is apt to be useful. Under cocain it is not commonly difficult to have the needful quiet for one or more attempts; but there is room for the exercise of the highest skill if prompt and full success is to be attained. Ample illumination is requisite, since much light will be cut off by the instrument, which is sometimes made with fenestrated jaws to lessen the obstruction to the view at the critical moment of seizing the object. Stoerk's tube-forceps with its pistol-grip is a very serviceable instrument, offering the minimum of obstruction and irritation by reason of its well-planned curves. A guarded knife is sometimes employed, as for laryngeal scarifications, to cut off growths; and the use of the chemical or galvano-cautery has been elsewhere described (see page 1004). Preparations for a tracheotomy should often be made before intralaryngeal operations are undertaken, since dangerous dyspnea or actual suffocation might at any time supervene.[1]

Laryngeal stenosis can often be dilated from the mouth by the passage of a suitable catheter, by divulsion with instruments like the author's dilator (Fig. 687), or by cutting and dilating, for which many instruments have been devised. (For Intubation by O'Dwyer's method, see page 1029.)

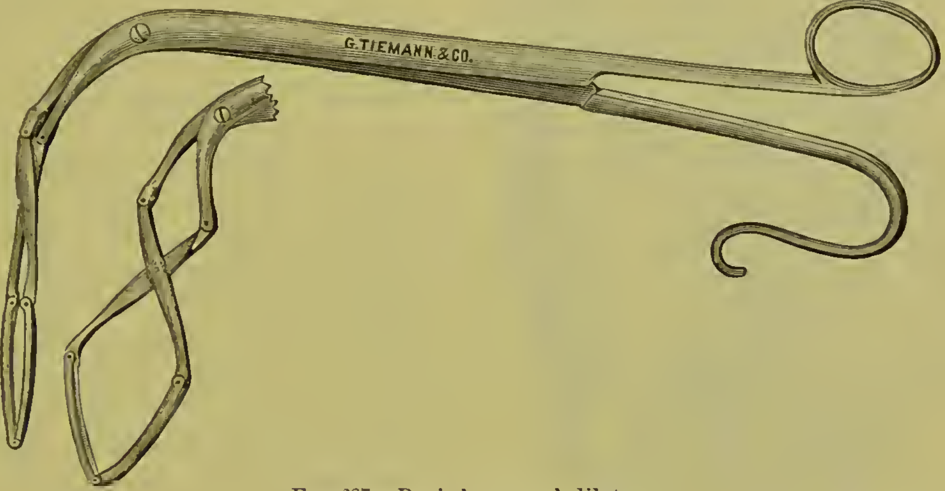

FIG. 687.—Roe's laryngeal dilator.

EXTERNAL OPERATIONS ON THE LOWER AIR-PASSAGES.

Tracheotomy, Thyrotomy, and Pharyngotomy.—External opening of the air-passages may be required for a number of conditions, chief among which is the prevention of suffocation by foreign body, false membrane, edema, abductor paralysis, or neoplasm. As a provision against the entry of blood into the lungs, it may be done preliminary to operations not otherwise requiring it; and its previous performance when the larynx is to be removed divides the shock of that operation and anchors the trachea to the external wound in a way that avoids some of the complications of the after-treatment. The need for it may be so sudden that little preparation is possible, and use must be made of whatever instruments are at hand—even a penknife having been successfully employed in an emergency. Morell Mackenzie carried an emergency cannula, the split obturator of which contained a sterile knife ready for immediate use.

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[1] The multiplicity of carefully-designed instruments for operation within the larynx are evidence of how much may be attempted in this difficult field by the expert laryngologist. Yet even if it were possible here to refer in detail to these procedures, no written description could materially aid the practitioner in acquiring the dexterity by which success has been achieved. For detail as to the removal of foreign bodies, see page 1133.

Where extreme limitation of time exists, penetration of the crico-thyroid membrane is usually indicated, for this structure is almost subcutaneous and generally devoid of vessels likely to cause troublesome hemorrhage. Additional space may be gained, if required, by cutting upward into the thyroid or downward through the cricoid; but without this a sufficient respiratory opening can be gained for the emergency, and more extensive operation in this region is at great risk of permanently impairing the voice.

Tracheotomy is generally to be preferred if a persistent opening and the wearing of a cannula is called for; and the opening may be made high or low, as the conditions of the case dictate. The presence of the thyroid gland and its vessels generally complicates the matter, and the fatness of the neck increases the annoyance caused by the tube, especially if the opening is low down, where the trachea is deeper and remains of the thymus gland are present in the very young. Yet the low operation is generally preferred because the space above the isthmus of the thyroid is small; and it is a decided complication to have to secure this structure with double ligatures and divide it to make room (Fig. 688). The isthmus generally covers the second, third, and fourth tracheal rings, and a process may extend up to the hyoid. The simplest method of hasty tracheotomy is that of Durham, who lightly grasps the trachea between the thumb and finger, pressed down until both carotids are felt, and then dissects down upon it as it presses forward into the wound. The veins, engorged by the impeded respiration, are generally easily seen and pressed aside, and the trachea is quickly laid bare and opened, either directly or after fixing and lifting it with a tenaculum. By Bose's method the median skin-incision is crossed by another at the level of the crico-thyroid membrane, laying this bare, and the undivided structures in front of the trachea are peeled down sufficiently to give access to it. As it is important to incise the trachea in the median line, great care should be taken to place the patient's neck and trunk straight, with the head drawn back over a rolling-pin or other firm support and immovably held there. In case of foreign body a retractor similar to a nasal speculum may be used to hold the trachea open, or a suture may be passed through each side of the tracheal wound and drawn upon whenever coughing promises to expel the obstructing object. Such threads are a very great

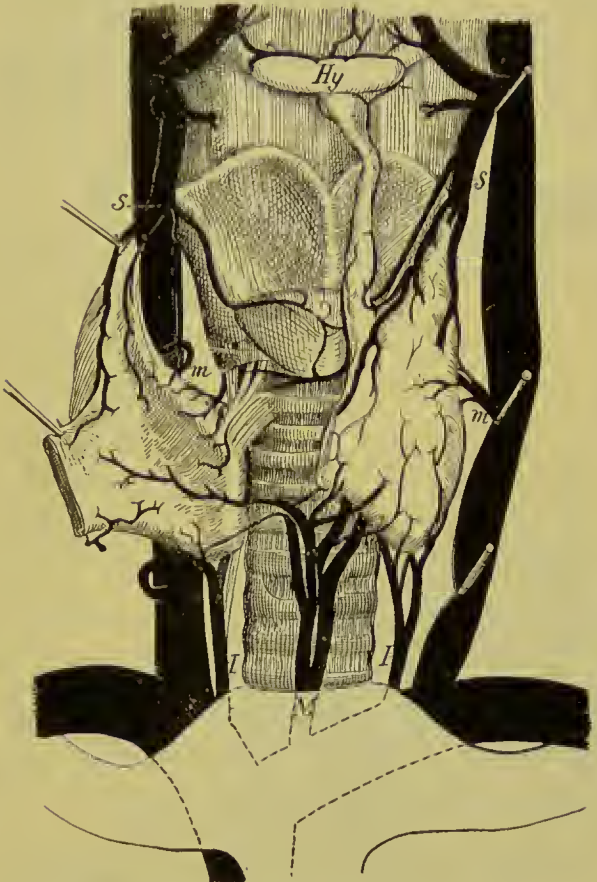

FIG. 688.—The trachea, larynx, and hyoid region, with the divided thyroid gland and the veins adjacent: the innominates are shown emptying into the cava and receiving the median (M) and inferior (I, I) thyroid veins; the superior (s, s) and middle (m, m) thyroid veins empty into the jugular (Farabœuf).

aid in placing the cannula in position at the first, and still more if it is to be replaced later after withdrawal for any cause; so Bosworth advises them as a rule. A portion of one or more rings may be resected in order to secure a gaping wound, and the margin of the tracheal and cutaneous wound on each side can be stitched together and a tube thus dispensed with.

Usually the operation can be performed with deliberate division of successive layers of the overlying tissues upon a grooved director, with all possible blunt dissecting, until the trachea is bared at the desired point and all bleeding vessels secured by compression or ligation. Then with a tenaculum a firm and central hold of the trachea is secured and the knife-point entered and the needful incision made upward and rather from within outward. Turning the knife-blade will separate the lips of the wound, while the finger-tip above will hold wide the external wound and prevent blood from being drawn in with the first deep gasping inspiration. The cannula may now be slipped in along the finger, and its obturator, if used, promptly withdrawn as soon as it is in the trachea. The tube is then secured in place by tying the tapes attached to its neck-plate around the patient's neck; and the external wound, if large, may be narrowed or closed around the tube by sutures.

General anesthesia is often quite unnecessary, as the patient is sufficiently narcotized by the semi-asphyxiation. Chloroform is generally preferred because less irritating to the air-passages and less liable to cause vomiting, with its dangers. Much care must be given to secure due warmth and moisture of the air entering by this shortened route, for fear of pneumonia, which may supervene from this, as from inspired blood, and may rob the operation of its life-saving value. [Steam-soaked air may be needless or even harmful, but the room should be warm and certainly not too dry.] Artificial respiration may be required to start breathing [or to continue it if it should be interrupted after the first free inspiration, as will occasionally happen, as if from shock, on the free entrance of air]; and the patient may need judicious stimulation for hours or days in order to rescue him from the profound carbonic-acid poisoning which has taken place during the apnea. The inner tube must be removed and cleansed whenever impeded by mucus or false membrane, and a feather may be passed through the cannula and down into the bronchi to remove collections and to stimulate cough.

The operation may be exceedingly simple and easy, or may be, as characterized by Billroth, one of the most difficult in surgery. Three or four assistants are desirable, each of whom must give full attention to his own duty, although it be the simple part of maintaining the head and neck in exact position. Full illumination, best secured by the concave forehead-reflector, is essential to the most skilful work. There must be no flurry or clumsiness at the crucial moment of introducing the tube, for many an operation has failed at this point—serious damage being done to the tissues, bleeding reawakened, or false membrane pressed down and impacted. The Trousseau double tube with its quadrant-curve is theoretically inferior to the more right-angled and adjustable tube of Durham; but it is the one most often employed by Americans. A well-made soft-rubber tube can have ample lumen and be much more comfortable to the patient and less likely to cause sloughing from pressure. Fenestrated tubes may permit and even cause ingrowth of granulations, with troublesome resulting erosion; while such construction is needless since enough air generally passes around the cannula to furnish sufficient breath for phonation. Where bleeding is to be especially guarded against, Trendelenburg's or Gerster's dilatable tube may be used; but a tight-fitting single tube can serve the same temporary purpose, and give place to one of better size at the close of the operation. Four sizes of tubes should be available, having an external diameter of ten, nine, seven, and five millimeters respectively.

The removal of the tracheotomy-tube after its purpose has been served may prove quite a troublesome matter, for the patient may have such severe dyspnea as to compel its reintroduction, and this may be difficult or even impossible through the narrowed wound, necessitating enlargement of it or resort to intubation. As the trouble may be largely hysterical, there is room for much tact in forestalling or overcoming it; and careful laryngoscopic examination should be made, if possible, before this removal is attempted, to make sure that the parts are in condition to resume their function.

Thyrotomy[1] or laryngo-fissure, often with preliminary tracheotomy, may be needed for the extirpation of broad-based growths or for foreign bodies impossible of removal by intralaryngeal methods. The cutaneous incision is to be made as for a high tracheotomy, from the hyoid bone to the cricoid ring; the rostrum of the thyroid is laid bare and divided centrally by gradually deepening cuts or by sawing if calcified. The mucous membrane should be exposed and all structures external to it divided and bleeding controlled before it is incised and the larynx opened, for very troublesome cough will be excited. The larynx-cavity should be entered from below under good illumination with the forehead-mirror, so that the vocal cords shall be seen and injury of them avoided. The purpose of the operation in extirpation of a growth or other step is to be then carried out after careful orientation, and the parts are brought together with all possible accuracy with silkworm-gut sutures, the skin-wound being separately stitched. The voice may be lost or permanently impaired by the operation, or not regained, as it sometimes might be, after consummate intralaryngeal work; yet if this latter is impracticable, the procedure is fully justified.

Subhyoid pharyngotomy may be needed to gain free access to the supraglottic space or the entrance of the esophagus, and the opening may be made immediately below the hyoid bone or just above the thyroid cartilage. The incision is made at the chosen level and from one sterno-mastoid to the other, and carried down through the muscles until the thyro-hyoid membrane is freely exposed. This is entered laterally, and the epiglottis brought to view and drawn out of the wound after sufficient enlargement, when the region should be open to free access. If found requisite, the incision can be carried down along the sterno-mastoid as a lateral pharyngotomy or esophagotomy. Great fear was at one time entertained as to any injury or removal of the epiglottis; but numberless cut-throat injuries have demonstrated that it may be lost by injury as by disease with little serious result. Yet feeding should be by tube (see page 1032) or by rectum for several days after this operation.

Extirpation and Resection of the Larynx.—Malignant growths of the larynx rarely admit of thorough extirpation by endo-laryngeal methods, and as a speedily fatal result with great suffering is the only natural outlook, severe operative measures are justified in their removal. [When very limited, it may be feasible by laryngo-fissure to extirpate the growth with preservation of the structure and the voice; but partial or total excision is generally needful if thoroughness is to be secured. This last is a serious measure, demanding much surgical skill and resource, which is often best done by the

---

[1] [The facile laryngoscopic operator will employ it more rarely than one less expert, and seems a little apt to decry it as needless and unduly risking the voice; but skilfully done it ought to entail only legitimate risks, due rather to the condition calling for it than to the operation itself.—Ed.]

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general surgeon rather than the laryngologist (see page 1113); yet many are better conversant with their cases than another can quickly become, and sufficiently versed in operative technic to make it well that they should direct if not perform the operation.]

Preliminary tracheotomy is generally advisable, and the patient may be allowed to recover fully and become habituated to the change before the graver intervention; although as performed by Perier and by Keen tracheotomy is not previously done. The larynx and upper portion of the trachea are sufficiently bared after free median incision and the grooved director passed behind the trachea, through the front of which a strong suture is passed just below the point selected as the lower limit of the excision. Traction upon this thread holds the trachea forward while it is cut across, and then draws it out of the wound; and a tightly fitting curved cannula is inserted and secured by tying the suture to a cleat upon it (Fig. 689). The anesthetic is transferred to this opening, while the larynx is lifted by a tenaculum and dissected up free from the esophagus and its upper attachments, and the excision completed according to the special requirements of the case. The trachea is stitched above the sternal notch into the wound, which is completely closed elsewhere if possible, the cannula being retained or not as the case seems to require. An artificial larynx may be later employed, although some patients have been able to talk without it.

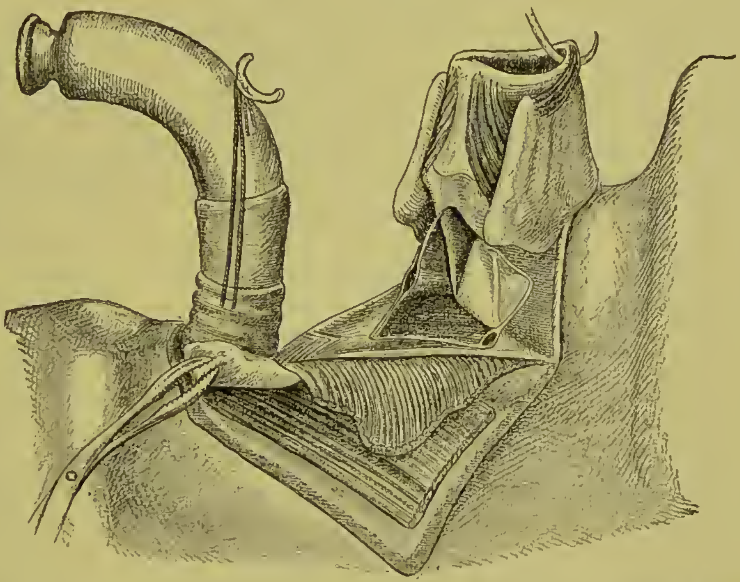

FIG. 689.—Extirpation of the larynx by Perier's method. The severed trachea is plugged with a tight cannula, and the larynx is lifted and dissected free from below.

Partial resection—*e. g.*, excision of one side of the larynx, is regarded as a much less grave procedure, which Bosworth advises as a first step after exploration by laryngo-fissure, and if the growth appears limited to that side; while J. N. Mackenzie urges that the extirpation should be as total as of the breast, and should include all suspicious neighboring lymphatics.

In all these operations placing the patient in the Trendelenburg position may facilitate the procedure and greatly reduce its risks. Shock is to be met by full employment of injection or transfusion of warm neutral salt-solution; and in case of carbonic-acid intoxication, simultaneous venesection with free bleeding has been employed with apparent advantage.

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